

# 1997 Annual Vegetation Report

## **1997 Annual Vegetation Report for the Rocky Flats Environmental Technology Site**

**Prepared for**

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## **EXECUTIVE SUMMARY**

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This report summarizes the results of the vegetation monitoring that was conducted at the Rocky Flats Environmental Technology Site (Site) during 1997. Vegetation monitoring is coordinated and conducted by Ecology Program personnel to provide baseline and current information on the Site's plant communities. This information is needed for effective conservation and management of the ecological resources at the Site. Activities include long-term qualitative and quantitative monitoring to detect changes in the plant communities over time, in addition to providing information for specific management decisions. Five discrete studies are summarized below and discussed in detail in the following sections of this report.

### **AGE/DIAMETER AND AGE/HEIGHT RELATIONS FOR THREE SPECIES**

An examination of the age/diameter and age/height relations for cottonwood trees, coyote willow, and leadplant was undertaken in different drainages at the Site to determine whether these relations would be robust and accurate enough for use in determining the ages of shrub and tree stands for Preble's meadow jumping mouse studies. Analyses revealed that the age/diameter and age/height relations were not consistent within drainages for each of the species, or between drainages (across the Site) for the shrub species (cottonwood trees were sampled in only one drainage). Thus, neither stem height nor diameter provides an accurate indicator of age for Site cottonwood trees or coyote willow shrubs, even though studies elsewhere have shown these characteristics to accurately reflect the ages of individuals. The most likely explanation for the inconsistency on Site has to do with the spatial and temporal variation in the availability of water. The various drainages exhibit marked differences in hydrology, and the streams are generally ephemeral. Thus, the best method for determining the age of these species on Site remains direct aging (i.e., tree coring).

### **EFFECTS OF 1996 WILDFIRE**

An investigation was concluded in 1997 that had been examining the effect of a late-summer grassland fire in the Buffer Zone (Labor Day, 1996) on the stem densities of diffuse knapweed, Canada thistle, and dalmatian toadflax. The fire burned relatively cool and moved quickly, and the question of interest was whether or not a controlled burn of similar timing and intensity would be an effective tool to help control these noxious weed species. The results of the study showed that the fire caused little to no reduction in the stem densities of these weed species. A positive impact of the fire however, was that much of the dead plant litter (thatch) that had built up over the years was removed, thereby reducing the potential for future wildfires in the area. The study also revealed the

importance of continued control of diffuse knapweed on Site, because over the one-year period of the study, stem densities increased an average of 105 percent in both the control and treatment plots.

## **EFFECTS OF HERBICIDE ON DIFFUSE KNAPWEED AND NATIVE SPECIES**

The herbicide Tordon 22K has been applied to diffuse knapweed on the Site, prompting a multi-year monitoring program, which began in 1997, to evaluate both its effectiveness on diffuse knapweed and any effects it may have on native prairie species. Preliminary results suggest that the herbicide is effective on diffuse knapweed, and is also having some impact on the native forb species. However, no conclusions can be drawn until the herbicide has had a year to take effect. Monitoring data from 1998 will be compared with the 1997 pre-treatment data, and these results will be presented in next year's annual report.

## **1997 XERIC TALLGRASS PRAIRIE MONITORING**

Monitoring at three xeric tallgrass prairie plots during 1997 revealed generally high similarity in species composition to other locations monitored previously on the xeric tallgrass prairie, although some variation was noted. Species richness varied from 77 to 89 species in the different plots, and 84–86 percent of these were native species. Foliar cover within the plots was dominated by mountain muhly, big bluestem, and Canada bluegrass. A number of weed species were recorded in the plots; the most significant was diffuse knapweed, which is a serious problem sitewide. The variation and differences found in the species composition at the xeric tallgrass prairie plots monitored in 1997, as compared to those monitored previously elsewhere on Site, reflect the variability in the soils and moisture availability across this plant community, as well as the effects of past land management, grazing, fire, and other local disturbances.

## **HIGH-VALUE PLANT COMMUNITY SURVEY**

The expanded evaluation of high-value plant communities, begun in 1996, continued in 1997 with additional qualitative monitoring to inventory plant species richness, map weeds and rare plants, provide photographic documentation, and evaluate the quality of the habitat to help document the status and any changes in the high-value plant communities on Site. The four high-value plant communities assessed were the xeric tallgrass prairie, tall upland shrubland, selected wetlands, and the Great Plains riparian woodland community. Species richness inventories documented 469 species of plants in these four communities, including four rare plant species (as designated by the Colorado Natural Heritage Program): the mountain-loving sedge, forktip three-awn, dwarf wild indigo, and carrionflower greenbrier. Although none of these species is protected by any regulatory status, their continued presence demonstrates the generally high quality of the Site's ecological resources.

Photographic documentation of the plant communities at the Site was initiated through the use of 45 permanently located photo plots, which were used to take 148 photographs of the plant communities in 1997. The photo plot locations were entered into the Site Geographic Information System (GIS) and linked to the photograph information using ArcView GIS software. This information will provide for repeatable documentation of visual changes in the plant communities through time.

## **CONCLUSIONS AND RECOMMENDATIONS**

Qualitative habitat assessments indicated that the Site's native plant communities appear generally healthy, although there are problems that threaten their long-term health and sustainability. The greatest natural threat in each community, especially the grasslands, is weeds. The weed species of greatest concern on Site is diffuse knapweed, which has invaded an estimated 2,678 acres (41% of the Site), based on maps produced in 1997. Other weed species, such as dalmatian toadflax, Russian thistle, mullein, musk thistle, curly-top gumweed, and Canada thistle, are also problems in the different communities.

During FY1997 and through March of FY1998, approximately 536 acres of grassland were treated with herbicides (Tordon 22K and Transline) to control diffuse knapweed. In addition, biological controls (insects) were released in 1997 at two locations to control diffuse knapweed and dalmatian toadflax. However, as suggested in previous reports, the use of herbicide treatments as the sole land management technique on Site is not recommended as a long-term solution for dealing with the weeds, or for wise management of the Site's ecological resources. Areas degraded because of weeds or disturbance need to be reseeded with native species, in addition to controlling weeds, to enhance the chances for long-term sustainability of the native plant communities. Eliminating the weeds without enhancing the native species only opens the door for other weed species to come in and take over. There must also be a commitment to restoring the natural processes and functions necessary to maintain a healthy, vigorous native ecosystem that can resist invasion from exotic species.

Another problem in the grassland communities has to do with plant litter or thatch buildup on the prairie. The high volume of plant litter at many locations in the grasslands (largely a result of a lack of fire and grazing) indicates that nutrients are tied up in the dead biomass, slowing the nutrient cycling in the ecosystem. Many of the native bunch grasses show signs of this stress. Buried in their own dead plant litter, they produce less plant material, and flower less. Without the use of controlled burns and grazing to help remove and recycle the thatch (both of which are natural processes that are necessary to sustain the grassland), the native species will continue to be stressed, and the potential for further degradation of the plant communities and invasion by weeds will increase. In addition, the high volume of thatch increases the potential for wildfires on the Site.

Effective management of the Site's high-value plant communities must include the balanced use of controlled burns, limited and controlled grazing, revegetation and

restoration of degraded areas, weed control, and habitat enhancement. From both an economic and ecological standpoint, the use of chemical weed control alone as a management tool is an expensive temporary bandage on a much larger problem. It is recommended that the land management practices begin to address the ecological processes and functions that are necessary to maintain a healthy ecosystem.

## Section 1

# **1. *POPULUS DELTOIDES*, *SALIX EXIGUA*, AND *AMORPHA FRUTICOSA* AGE/DIAMETER AND AGE/HEIGHT RELATIONS**

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This study was conducted to determine whether simple measurements of the height or diameter of individuals of coyote willow, plains cottonwood, or leadplant at the Rocky Flats Environmental Technology Site (Site) could serve as a basis for accurately determining the individual's age. If so, this method would be faster, more efficient, and less damaging than collecting cores or cutting stems from each individual and physically counting the rings in each.

This report first explains the purpose of collecting age data for these species and provides support from the literature for this method of determining the age of an individual. Field and laboratory methods are then presented, followed by study results, discussion, and conclusions.

## **1.1 BACKGROUND**

Studies at Rocky Flats Environmental Technology Site (Site) have indicated that the Preble's meadow jumping mouse (*Zapus hudsonius preblei*, which is now listed as a threatened species by the U.S. Fish and Wildlife Service; CFR 1998) populations on Site are most often found associated with areas of woody vegetation in the riparian corridors (K-Hill 1996a,b,c; 1998). These studies have further indicated that coyote willow (*Salix exigua*) is the woody species most often associated with their occurrence on Site. Protection of the riparian corridor vegetation from human disturbance and gaining a better understanding of the importance of the species composition and structure of the woody vegetation in relation to the Preble's mouse populations on Site has been an important concern over the past few years. A better understanding of the development and the dynamic nature of the riparian woodlands and shrublands at the Site, and how they relate to the distribution of the mouse, would provide important information for management and protection of the mouse. One issue is whether there is an optimal stand age and/or size (area, height) that provides the necessary habitat requirements, in addition to cover and density, required by the Preble's mouse.

Ottenbreit and Staniforth (1992) found a strong linear correlation between age/stem diameter and age/stem height for coyote willow on the Assiniboine River in Manitoba, Canada. They used this information to assist in determining the age structure, growth rates, life-history phases, sex ratio, and longevity of a large coyote willow population along the river. Hinchman and Birkeland (1995) suggested that site-specific age/diameter relations must be established before simple diameter measurements can be used to estimate

age, because of differences in the hydrogeomorphic conditions unique to each stream or river drainage.

During the 1997 field season, a project was begun to determine the age/diameter and age/height relations for coyote willow, plains cottonwoods (*Populus deltoides*), and leadplant (*Amorpha fruticosa*) in the different drainages at the Site. The purpose of this study was to determine whether an age/diameter or age/height relation was present for these species at the Site that would be suitably robust and accurate enough to be used in the future to assist in determining tree and shrub stand ages at different locations on Site. The study examined these relations between the different drainages on the Site and at a Site-wide level.

## 1.2 METHODS

Cottonwood trees were sampled only in Woman Creek during 1997, but may be sampled in the other drainages in the coming years. A total of 15 trees were selected from throughout the drainage, representing a wide range of diameters and heights. Nine of the samples were collected in May, and the remainder in September. Low tree density in the drainage, and the fact that many cottonwoods have rotten cores or trunks split low to the ground, prevented an accurate age determination for many individuals. Trees with solid trunks were selected subjectively to represent the range of diameters and heights in the drainage. Each tree sampled was assigned an identification number and tagged accordingly. The following information was recorded for each individual: diameter at breast height (DBH; approximately 1.4 m from the ground), tree height, and determination of age based on two tree cores (used average). The DBH (in centimeters) was measured using a tree-diameter tape, and tree height (in meters) was measured using a clinometer.

Two cores were taken of each tree at a height of approximately 1.4 m from the ground using a 12-in. Hagel increment borer. Cores were field stored in straws and air dried before aging. Age determinations were made by examining the cores under a dissecting scope, and the methodologies for tree coring and aging followed those of Cole (1977), Mowrer and Sheppard (1987), Campbell (1981), and Phipps (1985).

Shrubs were sampled in the Rock Creek, Walnut Creek, Woman Creek, and Smart Ditch drainages from late April through early May 1997. Both coyote willow and leadplant shrubs were sampled. Sampling followed the methods outlined by Ottenbreit and Staniforth (1992). In each drainage, a total of 20 stems of various diameters and heights were cut off at ground level for each of the two species (within 0-2 cm of the ground surface). Shrubs were selected from different locations throughout the length of each drainage. Each stem was given an identification number, which was recorded on the bark near the base of the cut stem with a permanent marking pen. For each stem, the height, stem diameter at the base, and age at the base were determined and recorded. The height of the stem was measured in centimeters and recorded in the field. The stem was then cut off, and only a 15- to 30-cm section from the base up was retained and taken to the laboratory.

In the laboratory, the diameter at the base of the stem was measured in millimeters from two directions (perpendicular to each other) using an electronic micrometer. The average of the two measurements was recorded for the stem diameter. The stems were stored in paper bags for approximately 6 months before age determinations were made. A fresh surface to use for aging was made by removing a segment of stem (approximately 6 mm) from the base of each stem. The cut segment was numbered with the same identification number as the stem, and the rings were counted in both freshly cut surfaces to age each stem. A dissecting scope and magnifying glass were used to aid in counting the rings.

Generally, the rings of the leadplant were easily distinguished, and only occasionally was any type of staining necessary to enhance them. With the coyote willow, staining was necessary in nearly every case, because the rings were so light. The staining method that worked the best for both the leadplant and coyote willow was to color the freshly cut surfaces with a yellow magic marker. This darkened the rings in contrast to the areas between them and allowed the rings to be counted.

Double or false rings are known to occur in softwood species such as cottonwood (Campbell 1981; Hinchman and Birkeland 1995), but other studies have shown that ring counts are accurate to within 10 percent of their actual age (Everitt 1968). For this study, each ring was considered to represent one year of age. For cottonwood age determinations, the ages reported are those at the DBH coring height. Ages were not adjusted to add the number of years required for the tree to reach that height.

Data for both the trees and shrubs were entered into a database and proofed for accuracy before analyzing the data. The age/diameter and age/height relations for each species were determined using a Pearson's correlation coefficient and simple regression analysis with Statgraphics software (Manugistics 1994). Because the goal of these analyses was to determine the usefulness of using either diameter or stem height as a means of estimating age, age was assigned as the dependent ( $y$ ) variable in the regression analyses (Fowler and Cohen 1990). Although the variables of age, stem diameter, and stem height were not normally distributed, no transformations of the data were performed before analysis. Rather, the raw data were used, so that comparisons could be made to other studies that had also used raw data. Prediction limits for age estimations were determined from the graphical output in Statgraphics. Analyses of shrub data were conducted for each species within each drainage, and for all drainages combined.

### 1.3 RESULTS

The age/stem-diameter relations for the coyote willow and leadplant in each drainage, and for all drainages combined, were strongly correlated, with the exception of coyote willow in Woman Creek, where the relation was very strongly correlated, and for leadplant in Walnut Creek, where the correlation strength was only moderate (Table 1-1). The regression results ( $r^2$ ) revealed that only 70 percent and 62 percent of the variation in age could

be accounted for by variation in stem diameter for coyote willow and leadplant, respectively, for all drainages combined (Table 1-2). The regression model graphs reveal the large variation in the age/stem-diameter data for coyote willow and leadplant (Figures 1-1a and 1-1c). The widths of the prediction limits from the regression models for coyote willow and leadplant for the age/stem-diameter data from all drainages combined were approximately 5.5 and 6.5 years, respectively (not shown).

Coyote willow had a much stronger correlation for age/stem height than did leadplant, as analyzed by each drainage and for all drainages combined (Table 1-3). The relation for coyote willow was very strongly correlated in Woman Creek and strongly correlated for all other comparisons (Table 1-3). The age/height relation for leadplant was only moderately correlated in most drainages, with the exception of Woman Creek, where it was strongly correlated. The regression results ( $r^2$ ) revealed that only 61 percent and 38 percent of the variation in age could be accounted for by variation in stem height for coyote willow and leadplant, respectively, for all drainages combined (Table 1-4). The regression model graphs reveal the large variation in the age/stem-height data for coyote willow and leadplant (Figures 1-1b and 1-1d). The width of the prediction limits from the regression models for coyote willow and leadplant for the age/stem-height data were approximately 6.5 and 8 years, respectively (not shown).

The cottonwood tree results from the Woman Creek drainage showed a strong correlation for age/stem diameter (0.77) but only a moderate correlation for age/stem height (0.53). The regression results ( $r^2$ ) revealed that only 59 percent of the variation in age could be accounted for by the variation in stem diameter and that only 28 percent of the variation in age could be accounted for by the variation in stem height. The regression model graphs show the large variation in both age/stem-diameter and age/stem-height data for the cottonwood trees (Figures 1-2a and 1-2b). The width of the prediction limits for cottonwood were 25 years or greater for both the age/stem diameter and age/stem height, based on the regression models (not shown).

The ages of the oldest cottonwood, coyote willow, and leadplant plants sampled were 40, 12, and 13 years, respectively (Figures 1-1 and 1-2). The average age, diameter, and height of the coyote willow and leadplant stems sampled are presented in Table 1-5. Based on the samples collected during 1997, the coyote willow grow in diameter and height by an average of approximately 4 mm and 56 cm annually, respectively (Table 1-5). Leadplant diameter and height increase each year by approximately 3 mm and 31 cm annually (Table 1-5). No calculations were made for the cottonwood trees in Woman Creek.

#### 1.4 DISCUSSION

This study examined the age/diameter and age/height relations for cottonwood trees, coyote willow, and leadplant at the Site to assess the usefulness of these measurements in determining the age structure of tree and shrub stands at different riparian locations on

Site. An understanding of the age structure of the on-Site stands of these species would provide knowledge on the dynamics of these populations within the community and could provide further insight into Preble's mouse distribution and use of these areas.

The results from this study indicate a great deal of variation in the ages, stem diameters, and stem heights in the on-Site cottonwood, coyote willow, and leadplant populations. Although the correlations for age/stem diameter were generally strong for each species, the regression analysis values ( $r^2$ ) indicated that the variations in age for each species could be only partially explained by the variations in stem diameter and stem height. Other factors generally explained more than 30 percent of the age variation for each species, which would make stem diameter or stem height measurements difficult to use to accurately determine the age of a stem. Additionally, the large range in the prediction limits (>5 years for coyote willow and leadplant; >25 years for cottonwood) would make the accuracy of such age estimates extremely low, especially considering that these ranges approach or exceed 50 percent of the age of the oldest individuals sampled. Thus, the measurement of stem diameter or stem height does not appear to be an appropriate means of estimating stem age for these species at the Site. Actual age determination of the shrubs or trees to be sampled would be required for any additional studies.

A number of factors may explain why the age/stem-diameter and age/stem-height relations of these species are so variable at the Site, and therefore of such little value in estimating age. Hinchman and Birkeland (1995) mentioned a number of studies done on cottonwood trees that showed large discrepancies with using stem diameter to predict age. Those studies showed that from 95 percent to as low as 18 percent of the variation in age could be accounted for by variation in stem diameter, indicating that the age/stem-diameter relation was not spatially consistent. Their study on Fremont cottonwood (*Populus fremontii*) age/stem-diameter relations along Cottonwood Creek and Red Tank Draw in Utah and Arizona, respectively, revealed regression analysis ( $r^2$ ) values of 82 percent and 75 percent for each area (Hinchman and Birkeland 1995). The differences between these creeks were attributed to different substrates, geomorphically distinct floodplains, differences in floodplain sedimentation, competition from other riparian plant species, and different disturbance regimes.

Differences in these variables may account for many of the inconsistencies found among drainages for the species sampled at the Site as well. Hydrogeological studies at the Site have documented the spatial distribution of gaining and losing reaches of Woman Creek, and how this distribution relates to both the locations of groundwater sources (seeps, springs, or bedrock paleochannels) and the elevations of stream-channel bottoms relative to groundwater elevations (EGG 1995). The variations found in Woman Creek are probably similar to the other streams on Site. Additionally, these studies also indicated that groundwater distribution within the surface deposits at the Site is influenced by factors that include surface and bedrock topography, seasonal variations in precipitation, surficial deposit thicknesses, the presence and location of engineered structures, and the presence of impermeable zones within the surface deposits (EGG 1995). As a result, the variations in the spatial and temporal availability of water on a small scale within each

drainage probably account for much of the variation in growth of each of these species along the drainages on Site.

Along the Assiniboine River in Manitoba, Canada, Ottenbreit and Staniforth (1992) obtained regression analysis ( $r^2$ ) values of 94 percent and 87 percent for the age/stem-diameter and age/stem-height relations for coyote willow. Their values were obtained from a single large population of coyote willow on a point bar along a large river. The Assiniboine River is large and flows are constant, and the growth rate and resulting growth rings reflect the uniformity of conditions present. Their resulting high values are in marked contrast to those for coyote willow obtained at the Site. The ephemeral nature of the stream flows at the Site and the variability of water availability at any given location probably account for much of the large variation in the age/stem-diameter and age/stem-height values observed in the species on Site.

## **1.5 CONCLUSION**

This study examined the age/diameter and age/height relations for cottonwood trees, coyote willow, and leadplant in different drainages at the Site. Analyses revealed that the age/diameter and age/height relations were not consistent within drainages for any of the species, nor between drainages (across the Site) for the shrub species (cottonwood trees were sampled in only one drainage). The most likely explanation for this variability is the spatial and temporal variation in the availability of water resulting from the hydrogeologic differences between drainages and the ephemeral nature of the streams on Site. As a result, the wide range of predictive limits shown for each of these species indicates that the ages of on-Site individuals of these species cannot be determined accurately on the basis of stem diameter or stem height. Therefore, the best method for determining the age of these species on Site remains direct aging (i.e., tree coring).

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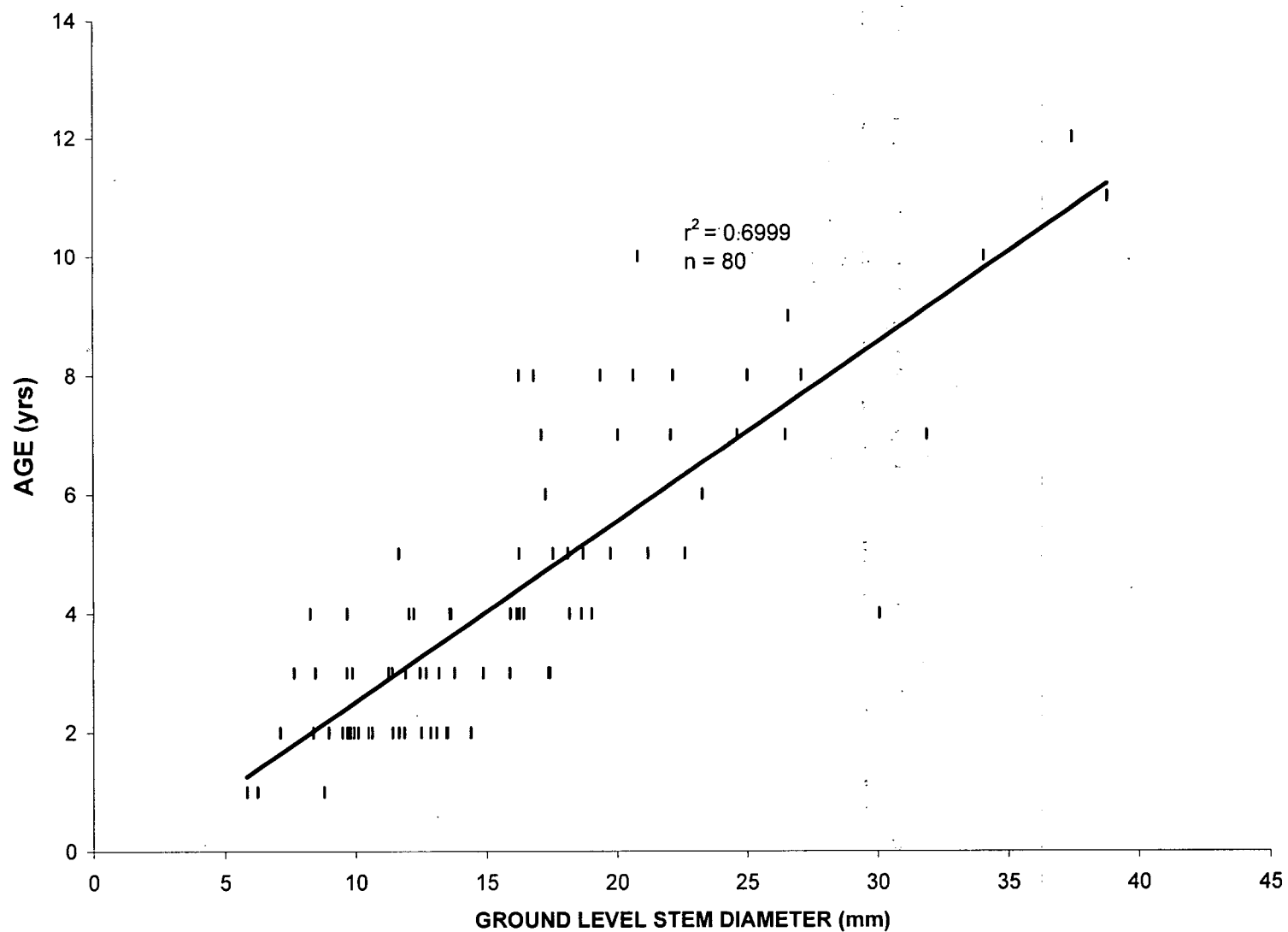


Figure 1-1a. Morphological characters as predictors of age in Coyote Willow populations at Rocky Flats Environmental Technology Site.

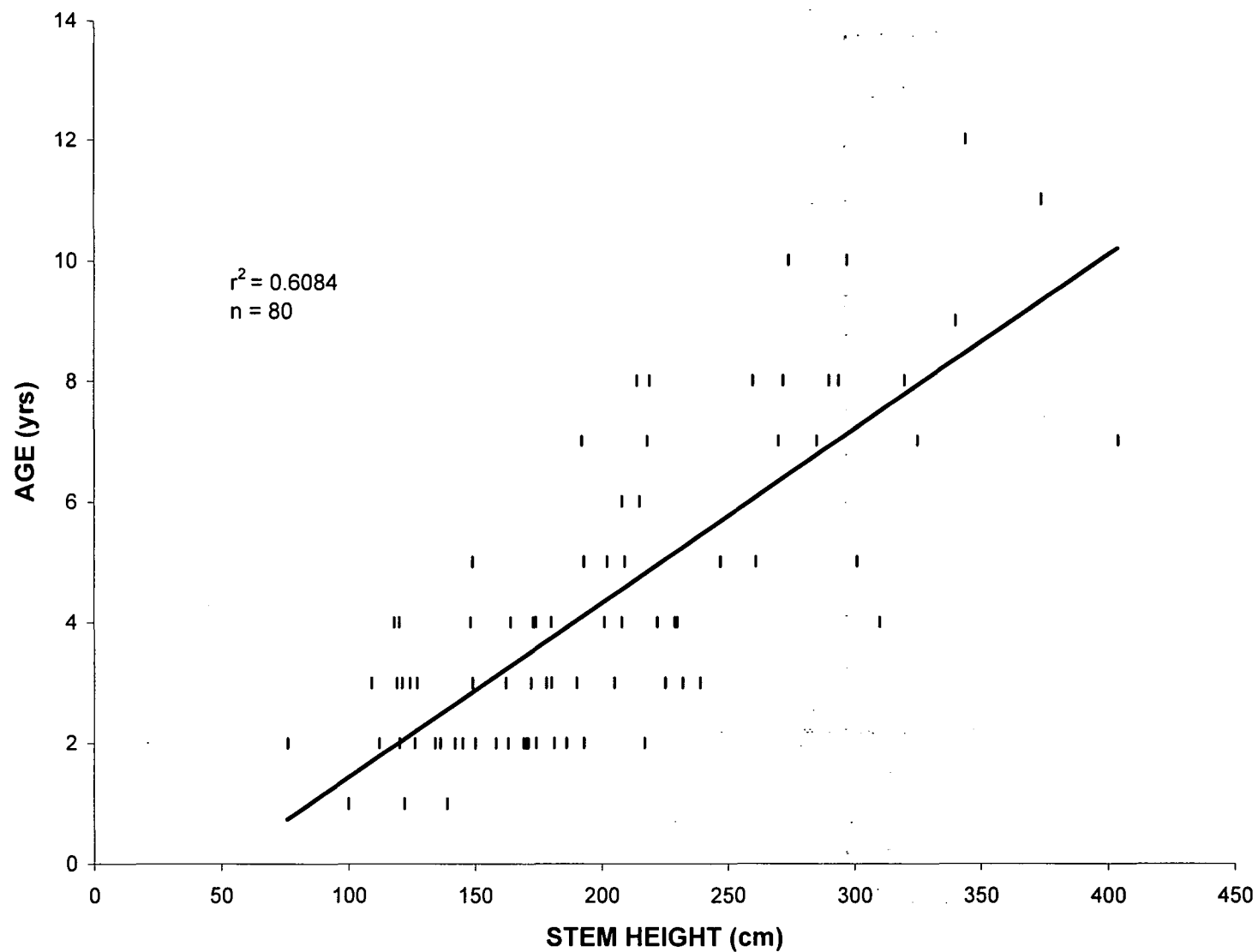


Figure 1-1b. Morphological characters as predictors of age in Coyote Willow populations at Rocky Flats Environmental Technology Site.

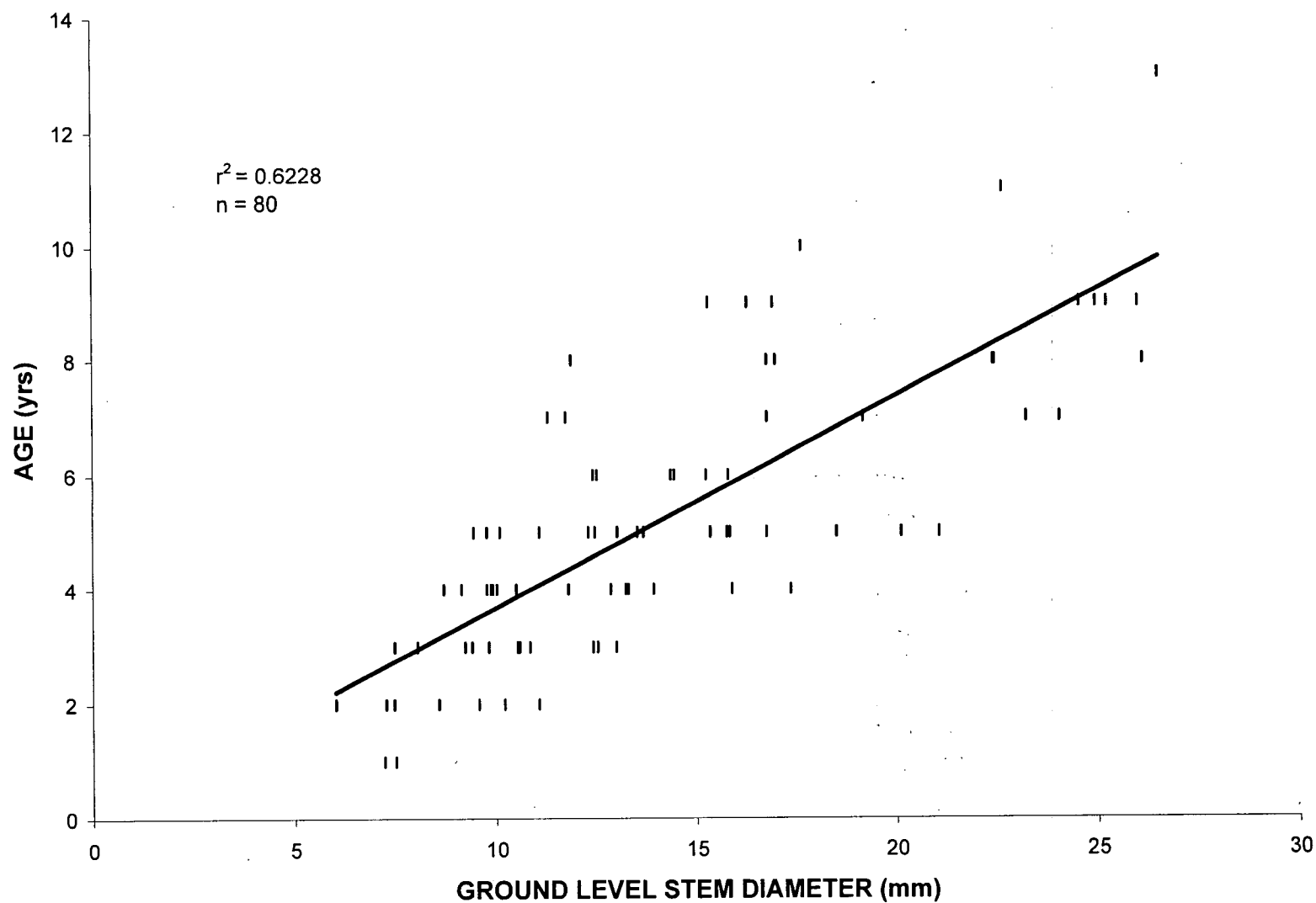


Figure 1-1c. Morphological characters as predictors of age in Leadplant populations at Rocky Flats Environmental Technology Site.

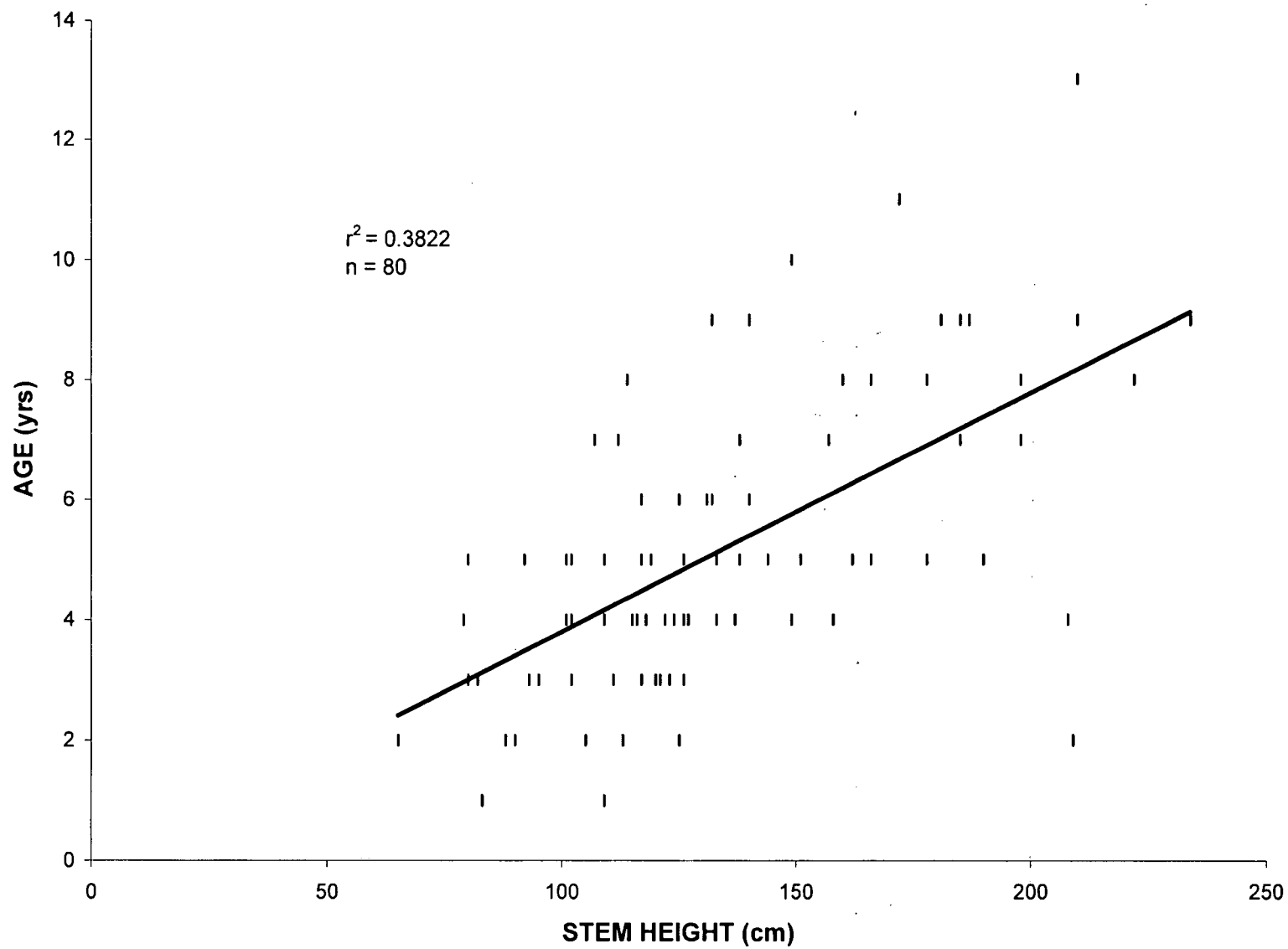


Figure 1-1d. Morphological characters as predictors of age in Leadplant populations at Rocky Flats Environmental Technology Site.

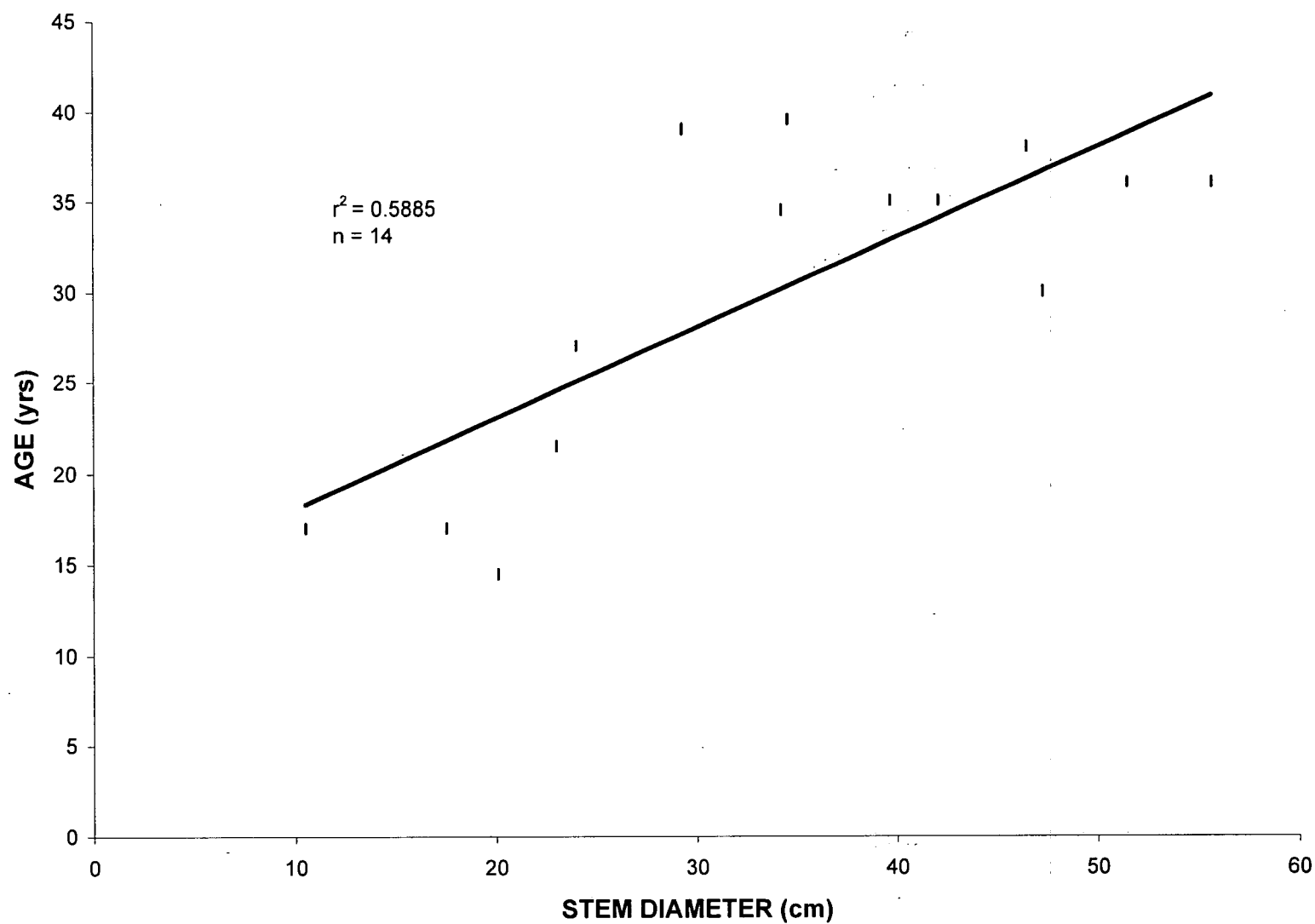


Figure 1-2a. Morphological characters as predictors of age in Cottonwood populations in Woman Creek at Rocky Flats Environmental Technology Site.

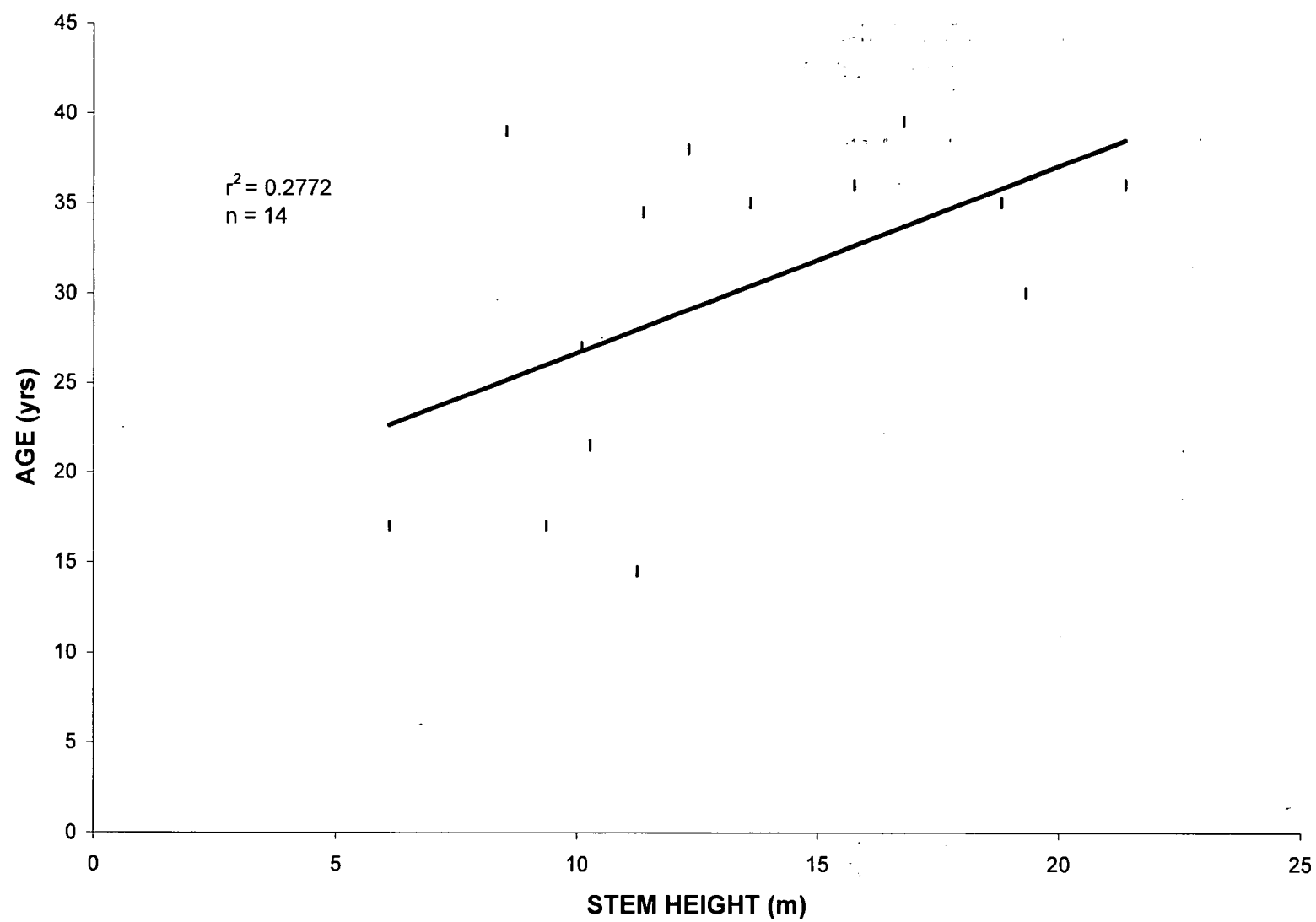


Figure 1-2b. Morphological characters as predictors of age in Cottonwood populations in Woman Creek at Rocky Flats Environmental Technology Site.

**TABLE 1-1. PEARSON'S CORRELATION COEFFICIENTS FOR AGE/DIAMETER  
RELATION FOR SELECTED WOODY SPECIES AT  
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE**

Drainage	<i>Salix exigua</i>	<i>Amorpha fruticosa</i>	<i>Populus deltoides</i>
Rock Creek	0.85	0.86	ND
Walnut Creek	0.74	0.67	ND
Woman Creek	0.93	0.88	0.77
Smart Ditch	0.87	0.76	ND
All drainages combined	0.84	0.79	ND

ND = No data.

n = 20 for individual drainages (shrubs).

n = 80 for all drainages combined (shrubs).

n = 14 for *Populus deltoides*.

**TABLE 1-2. REGRESSION ANALYSIS ( $r^2$ ) STATISTICS FOR AGE/DIAMETER  
RELATION FOR SELECTED WOODY SPECIES AT  
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE**

Drainage	<i>Salix exigua</i>	<i>Amorpha fruticosa</i>	<i>Populus deltoides</i>
Rock Creek	0.7218	0.7409	ND
Walnut Creek	0.5410	0.4499	ND
Woman Creek	0.8621	0.7789	0.5885
Smart Ditch	0.7544	0.5714	ND
All drainages combined	0.6999	0.6228	ND

ND = No data.

n = 20 for individual drainages (shrubs).

n = 80 for all drainages combined (shrubs).

n = 14 for *Populus deltoides*.

**TABLE 1-3. PEARSON'S CORRELATION COEFFICIENTS FOR AGE/HEIGHT  
RELATION FOR SELECTED WOODY SPECIES AT  
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE**

Drainage	<i>Salix exigua</i>	<i>Amorpha fruticosa</i>	<i>Populus deltoides</i>
Rock Creek	0.78	0.68	ND
Walnut Creek	0.74	0.41	ND
Woman Creek	0.91	0.77	0.53
Smart Ditch	0.86	0.61	ND
All drainages combined	0.78	0.62	ND

ND = No data.

n = 20 for individual drainages (shrubs).

n = 80 for all drainages combined (shrubs).

n = 14 for *Populus deltoides*.

**TABLE 1-4. REGRESSION ANALYSIS ( $r^2$ ) STATISTICS FOR AGE/HEIGHT  
RELATION FOR SELECTED WOODY SPECIES AT  
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE**

Drainage	<i>Salix exigua</i>	<i>Amorpha fruticosa</i>	<i>Populus deltoides</i>
Rock Creek	0.6116	0.4663	ND
Walnut Creek	0.5470	0.1655	ND
Woman Creek	0.8367	0.5941	0.2772
Smart Ditch	0.7475	0.3684	ND
All drainages combined	0.6084	0.3822	ND

ND = No data.

n = 20 for individual drainages (shrubs).

n = 80 for all drainages combined (shrubs).

n = 14 for *Populus deltoides*.

**TABLE 1-5. MEANS ( $\pm$ SD) OF DIAMETER, HEIGHT, AGE, AND GROWTH RATES OF  
COYOTE WILLOW AND LEADPLANT STEMS**

Variable	All Stems (n = 80)	
	Mean	Standard Deviation
Coyote Willow stem diameter (mm)	16.01	$\pm 7.02$
Coyote Willow stem height (cm)	200.48	$\pm 68.53$
Coyote Willow age (yr)	4.33	$\pm 2.53$
Coyote Willow annual diameter increment (mm/yr)	4.22	$\pm 1.41$
Coyote Willow annual height increment (cm/yr)	55.91	$\pm 23.65$
Leadplant stem diameter (mm)	14.12	$\pm 5.24$
Leadplant stem height (cm)	135.11	$\pm 38.06$
Leadplant age (yr)	5.20	$\pm 2.45$
Leadplant annual diameter increment (mm/yr)	3.02	$\pm 1.09$
Leadplant annual height increment (cm/yr)	31.04	$\pm 16.85$

## Section 2

## 2. EFFECTS OF A LATE-SUMMER GRASSLAND FIRE ON CANADA THISTLE, DIFFUSE KNAPWEED, AND DALMATIAN TOADFLAX

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### 2.1 INTRODUCTION

On Labor Day, September 2, 1996, lightning caused a wildfire that swept across approximately 105 acres of grassland in the Buffer Zone south of the Industrial Area at Rocky Flats Environmental Technology Site (Site). Observations the next day suggested that the fire moved fast and was relatively cool. While most of the litter and much of the live biomass were removed, the taller weed species—diffuse knapweed (*Centaurea diffusa*), Canada thistle (*Cirsium arvense*), and dalmatian toadflax (*Linaria dalmatica*)—were not consumed and remained standing. The mature plants of these species were only scorched at the base, leaving current-year stalks still standing, and rosettes only had their leaf tips scorched. As a result, it was still possible to determine pre-burn stem densities for these species.

These three species are considered noxious weeds, and a question of interest was whether a controlled burn of similar timing and intensity would be an effective management tool for controlling these species. Therefore, a study was designed to examine what effect the late-summer grassland fire had on the stem densities of these weeds. Data produced were analyzed to test the hypothesis that no difference was evident between the pre-burn and post-burn (one year after the fire) stem densities of diffuse knapweed, Canada thistle, and dalmatian toadflax.

### 2.2 METHODS

The study was designed using both unburned (control treatment) and burned (treatment) areas where diffuse knapweed, Canada thistle, and dalmatian toadflax appeared to be present in similar amounts. The control and treatment areas for the diffuse knapweed and Canada thistle plots were selected adjacent to each other across the edge of the fire line, although half of the unburned diffuse knapweed plots were located across a gravel road where the fire had burned up to the road's edge. Only two small unburned areas of dalmatian toadflax were present adjacent to burned ones, though, so the closest nearby unburned area of dalmatian toadflax with similar physical conditions was chosen to make up most of the area for studying unburned plants.

The soil type in the diffuse knapweed sample areas was Flatirons very cobbly sandy loam (SCS 1980). At the Canada thistle locations, the soil type was Denver-Kutch-Midway clay loam (SCS 1980). The soil type in the dalmatian toadflax sample areas was Nederland very cobbly sandy loam at the burned locations, and at four of the quadrats in the

unburned area (SCS 1980). However, the other six unburned quadrats were located on the Denver-Kutch-Midway clay loam, because no other locations of dalmatian toadflax were found nearby on Nederland very cobbly sandy loam.

Ten replicate, square quadrats of 1 m<sup>2</sup> each were located at random in each of the unburned and burned areas for each species. Table 2-1 lists the different species and the number of plots sampled for each treatment. Each quadrat location was staked with rebar at one corner, and quadrats were oriented using a compass so that the edges were aligned N-S and E-W. The corner staked for each quadrat was recorded so the quadrat could be repositioned accurately for future sampling.

Stem densities of the three weed species were counted and recorded for each quadrat at each location. Both stalks and rosettes were counted, and their numbers were summed for the total stem density per quadrat. Diffuse knapweed and Canada thistle rosettes were easily seen and counted. Dalmatian toadflax "rosettes" were considered to be the small (under 3–5 cm) new growth found at the base of old stems, and any new stems that were not associated with old ones. Sampling was conducted in fall 1996, spring 1997, and fall 1997.

Data were entered and quality checked prior to analysis. Data were summarized by species using the 10 quadrats sampled for each treatment (n = 10). Between-treatment analyses for each species within each year were conducted using a t-test (P = 0.05) where normality and variance requirements were met (Manugistics 1994). Where normality or variance requirements were not met, a Mann-Whitney U test was used (P = 0.05; Fowler and Cohen 1990). Between-year differences in stem densities by species within treatment types were analyzed using either paired t-tests or paired signed rank tests, depending on whether normality and variance requirements were met (Manugistics 1994). Statistical analyses were done using Statgraphics Plus software (Manugistics 1994) or, in the cases where Mann-Whitney U tests had been used, were hand calculated.

## 2.3 RESULTS

The results for each of the species and treatments are shown in Table 2-2 and Figures 2-1 through 2-3. Diffuse knapweed stem densities increased in both the unburned and burned areas from fall 1996 to fall 1997 (Table 2-2 and Figure 2-1). The diffuse knapweed stem density increases were significantly different using a paired t-test (P < 0.05) for the unburned area and a signed rank test for the burned site (P < 0.05). Canada thistle stem densities in the burned area increased significantly from fall 1996 to fall 1997 (paired signed rank test, P < 0.05; Table 2-2 and Figure 2-2). However, Canada thistle stem densities in the unburned area decreased from fall 1996 to fall 1997 (Table 2-2 and Figure 2-2), but the decrease was not found to be significant using a paired signed rank test (P < 0.05). Dalmatian toadflax stem densities decreased significantly in both the unburned and burned areas from fall 1996 to fall 1997 (paired t-test, P < 0.05; Table 2-2 and Figure 2-3).

## 2.4 DISCUSSION

Diffuse knapweed stem densities showed significant increases in both the unburned and burned quadrats, suggesting that the late-summer grassland fire had a negligible impact on the stem density of this species. The increase in stem density in both the unburned and burned treatments may simply indicate that conditions during this time favored the growth of knapweed.

One important fact revealed by the data from both the unburned and burned quadrats is that diffuse knapweed has the potential for explosive growth. In this study, the unburned and burned quadrats combined saw an average increase of 105 percent in the stem density of diffuse knapweed over this one-year period. If this rate of increase is typical for diffuse knapweed, then the need to control its spread is urgent, and efforts may need to be expanded beyond those currently underway to control on-Site infestations.

Dalmatian toadflax stem densities decreased significantly in both the unburned and burned quadrats, also indicating that the fire's effect was negligible. Conditions during this year apparently were not optimal for growth of dalmatian toadflax.

Only Canada thistle seemed to respond differently in the unburned and burned quadrats. Stem densities increased significantly in the burned plots and decreased (though not significantly) in the unburned plots, potentially indicating that the fire increased Canada thistle stem densities. However, the fall 1997 sampling revealed no statistically significant difference between the unburned and burned quadrats, so the data did not substantiate the apparent increase. Further investigation would be required to determine whether a late-summer fire would have any long-term impact on the density of Canada thistle.

## 2.5 CONCLUSIONS

The results of this investigation suggest that the late-summer grassland fire had little to no impact on the stem densities of diffuse knapweed, Canada thistle, or dalmatian toadflax over a one-year period. Although this study indicates that controlled burns would be of little use in reducing the stem densities of these species, the use of fire might indirectly improve the health and vigor of the native species, which could then allow them to compete better with the weed species. Further investigation would be required to examine the longer-term impacts of the fire on the competition and use of resources by native species versus weed species.

The large increase in the stem density of diffuse knapweed over the one-year period continues to underscore the need for increased efforts to control this noxious weed at the Site.

## **2.6 REFERENCES**

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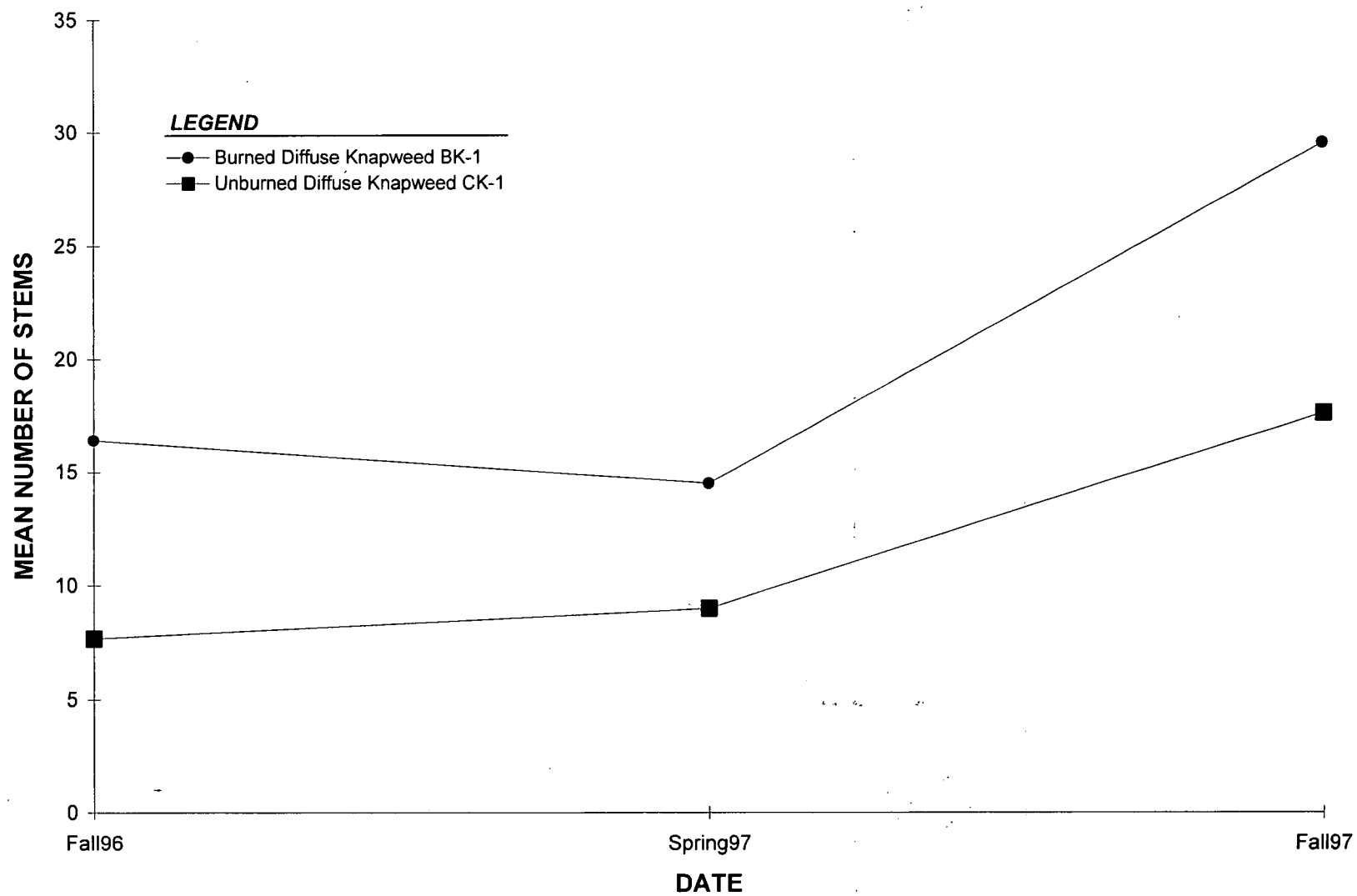


Figure 2-1. Diffuse knapweed densities from 1996-1997.

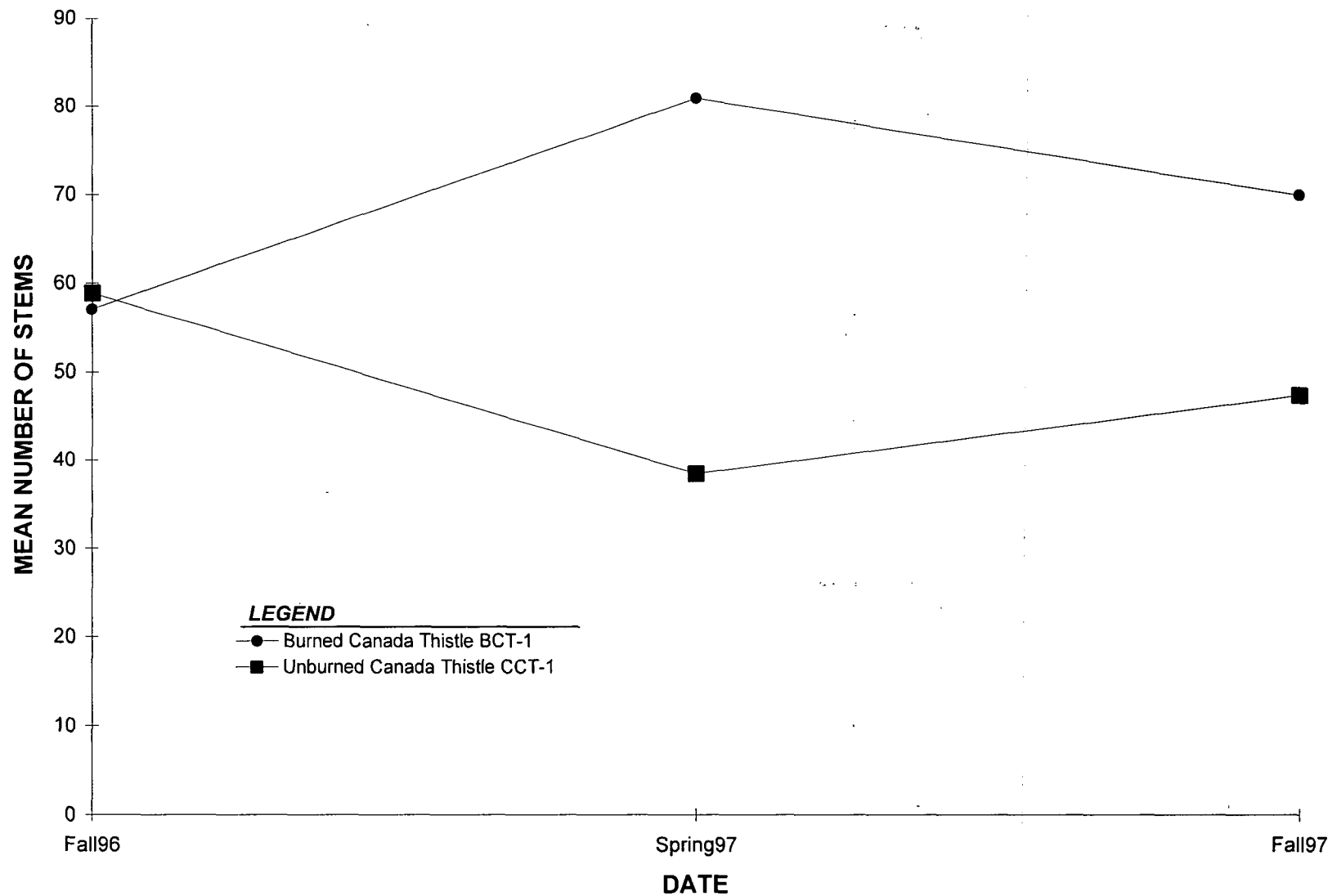


Figure 2-2. Canadian thistle densities from 1996-1997.

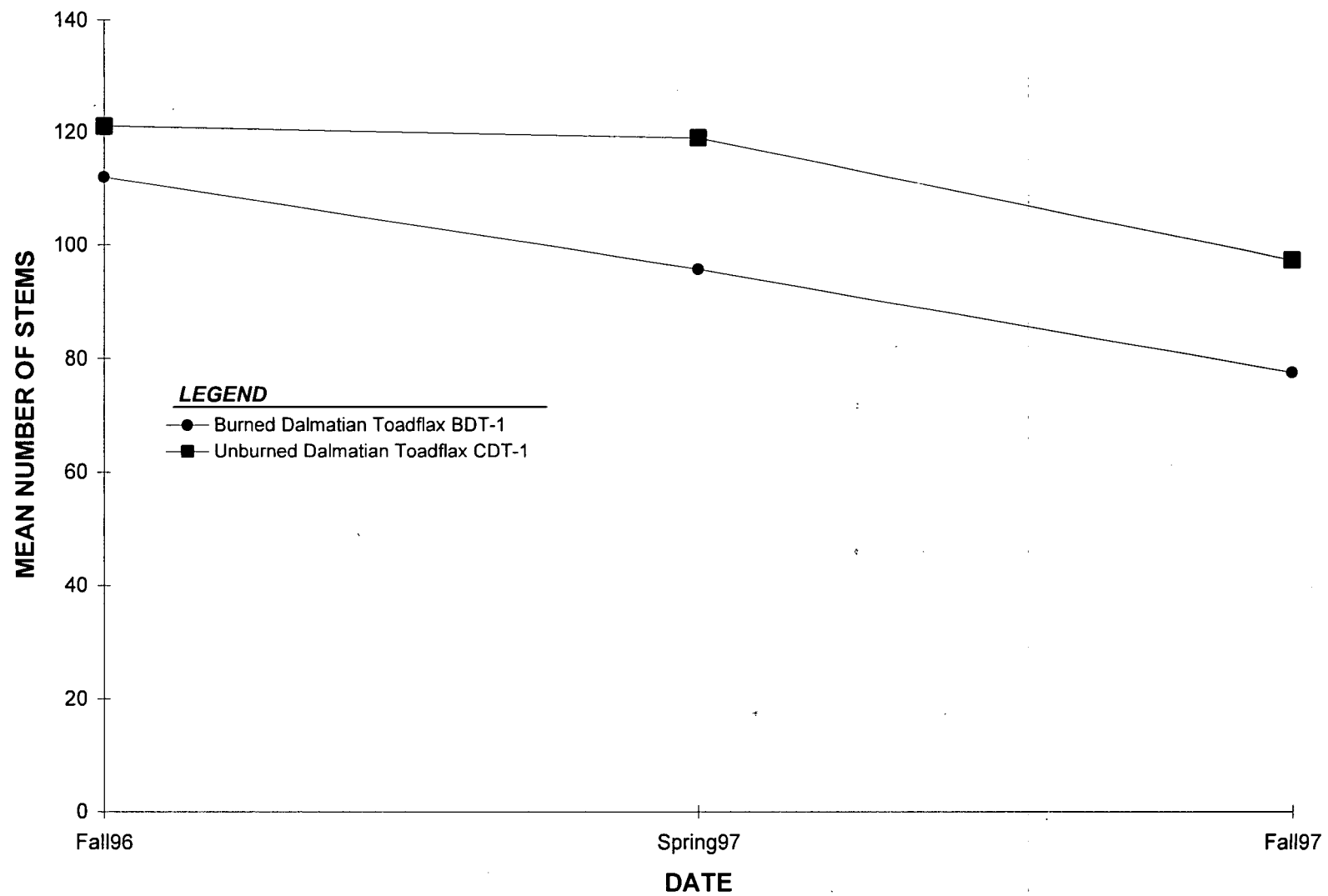


Figure 2-3. Dalmatian toadflax densities from 1996-1997.

**TABLE 2-1. CONTROL AND TREATMENT PLOT INFORMATION**

Treatment	Species	Number of Plots
Burned	Diffuse Knapweed	10
Burned	Canada Thistle	10
Burned	Dalmatian Toadflax	10
Control	Diffuse Knapweed	10
Control	Canada Thistle	10
Control	Dalmatian Toadflax	10

**TABLE 2-2. MEAN NUMBER OF STEMS  
1996 LABOR DAY GRASSLAND FIRE**

Treatments	Site ID	Fall 96	Spring 97	Fall 97
Burned Diffuse Knapweed	BK-1	16.4a	14.5	29.5b
Unburned Diffuse Knapweed	CK-1	7.7a	9	17.6b
Burned Canada Thistle	BCT-1	57.1a	80.9	69.8b
Unburned Canada Thistle	CCT-1	58.9a	38.4	47.3a
Burned Dalmatian Toadflax	BDT-1	112.1a	95.7	77.5b
Unburned Dalmatian Toadflax	CDT-1	121.1a	118.9	97.3b

No significant differences between treatments for each species were found for Fall 96 or Fall 97. Differences in letters across rows denote significant differences between years ( $P < 0.05$ ).

### Section 3

### 3. EFFECT OF TORDON 22K ON DIFFUSE KNAPWEED AND NATIVE PLANT SPECIES IN THE XERIC TALLGRASS PRAIRIE

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#### 3.1 INTRODUCTION

Over the past several years, weed control has become a serious issue in managing the natural resources in the Buffer Zone at Rocky Flats Environmental Technology Site (Site). The weed species causing the most concern at the Site is diffuse knapweed (*Centaurea diffusa*). Under the Colorado Noxious Weed Act, diffuse knapweed is listed as a noxious weed that must be controlled by property owners, and it is listed as one of the top ten prioritized species for control in the state (CRS 1996).

Diffuse knapweed is a very aggressive competitor in dry conditions such as those found at the Site. Studies elsewhere have shown that it rapidly invades overgrazed rangelands, disturbed sites, and even undisturbed plant communities, often becoming a dominant species and altering the native species composition (FEIS 1996). Over the past 5 years, diffuse knapweed has spread rapidly across the Site. Weed mapping done in late summer 1997 shows that approximately 41 percent of the Site now has some level of diffuse knapweed infestation. Furthermore, the Site contains a significant portion of what has been identified as the largest remaining stand of relict xeric tallgrass prairie known to occur in Colorado, and potentially in all of North America (CNHP 1995), and this plant community is one of those being affected by diffuse knapweed infestations.

The chemical Tordon 22K (Trademark of DowElanco) has been found to effectively control diffuse knapweed, providing a multi-year residual effect that can prevent the species from germinating for several years after its application (Beck 1994). It was used on Site for the first time in 1997. However, a management concern was what effect the spraying of Tordon 22K would have not only on the diffuse knapweed but also on the native species in the xeric tallgrass prairie.<sup>1</sup> Therefore, the purpose of this study was to gather onsite data that would answer the two-part question, "Does Tordon 22K control diffuse knapweed under Site conditions, and does the chemical affect the native species in the xeric tallgrass prairie?"

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<sup>1</sup> In a Montana study on spotted knapweed (*Centaurea maculosa*; a relative of diffuse knapweed), the use of Tordon 22K had a relatively low impact on the native plant species (Rice and Toney 1996).

### 3.2 QUESTIONS

This study was initiated in 1997 to assess the effectiveness of Tordon 22K at controlling diffuse knapweed, and to assess the chemical's effect on the xeric tallgrass prairie. Specific questions addressed by this study were:

- Is the application of Tordon 22K having the desired effect on diffuse knapweed (i.e., reducing or eliminating its presence from the xeric tallgrass prairie)?
- Under Site conditions, for how long will a single application of Tordon 22K continue to keep the diffuse knapweed population at tolerable levels?
- Because Tordon 22K is a general broadleaf herbicide, is it affecting species richness (i.e., eliminating any of the native forb species) in the xeric tallgrass prairie?
- Is Tordon 22K affecting the total foliar cover, total basal cover, and individual species cover amounts in the xeric tallgrass prairie?<sup>2</sup>
- What impact is the spraying of Tordon 22K having on the frequency of occurrence of diffuse knapweed and native species in the xeric tallgrass prairie? This question provides additional information for use in interpreting the cover data.

### 3.3 METHODS

The area selected for the study was located north of the T130 trailer complex west of the Industrial Area on Site (Figure 3-1). The xeric tallgrass prairie at the Site is located primarily on the pediment, which is underlain by Rocky Flats alluvium (SCS 1980). The soils are classified as Flatirons very cobbly sandy loams (SCS 1980). The study site was essentially flat, with only a 1° slope to the northeast. The site was selected because 1) it was large enough for placement of both control and treatment plots (each plot was 60×65 m), and 2) the area where the two plots would be located appeared to contain a large amount of diffuse knapweed.

Once the plots were laid out, five parallel, randomly located 50-m transects were established from a baseline using X and Y coordinates generated by a computer random number

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<sup>2</sup> The concern here is that if the spraying significantly reduces the cover afforded by the native species, and/or increases the amount of bare ground by killing native species, there is potential for further stress on the health of the native community. This stress could provide an opportunity for other weed species to establish in the xeric tallgrass prairie and/or create greater erosion potential.

generator (Figure 3-2). Transects were permanently marked, assigned numbers, and labeled accordingly. Pre-treatment sampling was conducted during May 17–19.

During June 16–24, Tordon 22K was applied to the treatment plot at a rate of 1 pint/acre using a truck-mounted spray unit with a 55-ft boom positioned approximately 2–3 feet above the vegetation. A uniform application rate was obtained across the area using a computerized spray system, which regulated the application pressure rate according to the speed of the truck. Post-treatment sampling was conducted during September 2–4.

Species richness was determined in a 2-m-wide belt centered along the length of each 50-m transect. Every plant species rooted within the 100-m<sup>2</sup> area was recorded. In addition, the densities of the woody plant stems and cactus species were counted and recorded in the 100-m<sup>2</sup> area. Basal cover and foliar cover estimates were made using a point-intercept method along each 50-m transect. A 2-m-long rod, with a 6-mm diameter, was dropped vertically at 50-cm increments along the transect to record a total of 100 intercept points. Two types of hits were recorded. Basal cover hits were recorded on the basis of what the rod contacted at the ground surface. Hits could be vegetation (live plants), litter (fallen dead material), rock (pebbles and cobbles that were greater than the rod diameter), bare ground, or water, in that order of priority based on the protection from erosion provided by each type of cover. Basal vegetation hits were recorded only if the rod was touching the stem or crown of the plant where it entered the ground. Foliar vegetation hits (defined as a portion of a plant touching the rod) were recorded in three categories as defined by height and growth form. The topmost hit of each growth form was recorded. The growth forms measured were herbaceous, woody <2 m in height, and woody >2 m in height.

Frequency information was gathered by species by randomly locating 25 1-m<sup>2</sup> quadrats (5 per transect) in each of the control and treatment plots and recording all species present in each plot. Density counts for the species diffuse knapweed, St. John's-wort (*Hypericum perforatum*), and curly-top gumweed (*Grindelia squarrosa*) were also made using these same quadrats. More detailed summaries of these specific methods are found in the *Environmental Monitoring Department Operating Procedures Manual* (DOE 1995) and the *High-Value Vegetation Survey Plan for the Rocky Flats Environmental Technology Site* (K-H 1997).

Species richness data were summarized by generating a species list for the control plot and treatment plot. A Sorenson coefficient of similarity index (Brower and Zar 1977) was used to evaluate the species richness similarity of the control versus treatment plots. In addition, other species richness variables were calculated from the species lists. Basal cover data were reported as total percent cover of vegetation, litter, rock, bare, and ground.

Foliar cover data were reported as frequency, relative cover, and absolute cover for each species encountered. From the cover data, frequency was defined as the percent of point-intercept transects on which a species occurred, out of the possible five sampled in each

plot. Absolute foliar cover was the percentage of the number of hits on a species out of the total number of hits possible at a plot (500). Relative foliar cover was the number of hits a species had relative to the total number of vegetative hits recorded per plot (i.e., the percent of vegetative cover represented by the species). Both absolute and relative foliar cover values are mean values.

Frequency based on quadrats ( $n = 25$ ) was defined as the number of quadrats in which a species was recorded divided by 25 (the total number of quadrats possible), multiplied by 100. Density counts were summarized as the mean number of stems per square meter. No statistical analysis was conducted on the data from 1997, because a second year of data is necessary for comparison.

Because 1997 was the first year of a multi-year study, the information presented in this report constitutes a baseline summary of the control and treatment plots for 1997. Some descriptive comparisons between the control and treatment plots are included in this report, as are some general statements concerning the pre- and post-treatment data. The questions posed at the beginning of the study will be addressed more thoroughly after the 1998 sampling, when a multi-year data set is available.

### **3.4 RESULTS**

#### **3.4.1 Species Richness**

Species richness results for the control and treatment areas are shown in Table 3-1 for the 1997 pre-treatment and post-treatment sampling. Species lists for the pre- and post-treatment control and treatment plots are presented in Table 3-2. Pre-treatment sampling showed a total of 68 species present in the control plot transects, compared to 74 species recorded at the treatment plot transects (Table 3-1). The number of species declined by only three in the control area after treatment, but the treatment area showed a decline of 12 species (Table 3-1).

Examination of the treatment plot species lists from pre- and post-treatment sampling (Table 3-2) revealed that the decline in numbers was due to loss of forb species, many of which were spring ephemeral species. The same graminoid species were present in the treatment plot during both sampling events. The mean number of species per quadrat declined slightly in both the control and treatment plots (Table 3-1). A Sorenson coefficient of similarity of 0.81 was calculated for pre-treatment species richness in the control plot versus the treatment plot (Brower and Zar 1977). The percentage of native species was essentially the same in the control and treatment plots both before and after treatment (Table 3-1).

### 3.4.2 Cover

Total foliar cover and litter cover were higher in the control plot than in the treatment plot during pre- and post-treatment sampling, but both the control and treatment plots showed an increase for both cover types as the summer progressed (Table 3-1). Total basal vegetation cover was initially the same in the control and treatment plots before treatment, and declined slightly in both plots after treatment (Table 3-1). Rock cover was higher in the treatment plot during both sampling periods, but both the control and treatment plots showed declines in rock cover by late summer (Table 3-1). Bare ground cover was higher in the control plot before treatment, but was higher in the treatment plot after treatment, although both plots showed declines (Table 3-1).

The dominant species in both the control and treatment plots were mountain muhly (*Muhlenbergia montana*), Canada bluegrass (*Poa compressa*), and big bluestem (*Andropogon gerardii*), with percent relative foliar covers of 34.0, 25.2, 12.6, and 39.6, 18.3, and 7.5, respectively, in the control and treatment plots, during the pre-treatment sampling (Table 3-3). The cover represented by each of these species increased during the summer, with the exception of mountain muhly in the control plot and Canada bluegrass in the treatment plot, both of which declined slightly (Table 3-4). The percent relative foliar cover represented by diffuse knapweed increased in the control plot from spring to summer (3.8 percent and 6.1 percent, respectively; Tables 3-3 and 3-4) and stayed approximately the same in the treatment plot (6.6 percent and 6.8 percent, respectively; Tables 3-3 and 3-4).

The percentages of native foliar cover in the control and treatment plots were essentially equal during pre-treatment sampling (69 percent and 68 percent, respectively; Table 3-1). After treatment, however, the control plot native foliar cover had dropped to 66 percent, while the treatment plot native foliar cover had increased to 72 percent (Table 3-1). Much of the loss of native foliar cover in the control plot was due to a loss of native cover of mountain muhly and an increase in non-native foliar cover of diffuse knapweed (Tables 3-3 and 3-4). In the treatment plot, the increase in native foliar cover was largely due to an increase in the cover represented by the native species mountain muhly and big bluestem (Tables 3-3 and 3-4).

### 3.4.3 Weed and Cactus Density

Before treatment, the diffuse knapweed density was much higher in the treatment plot (23.0 stems/m<sup>2</sup>) than in the control plot (5.6 stems/m<sup>2</sup>; Table 3-1). However, post-treatment sampling revealed that the diffuse knapweed density in the treatment plots had dropped considerably (to 6.1 stems/m<sup>2</sup>), but was still nearly twice that in the control plot (3.6 stems/m<sup>2</sup>; Table 3-1). Curly-top gumweed density was slightly higher in the control plot than in the treatment plot, both before and after treatment, but the density declined in both plots after treatment (Table 3-1). The density of St. John's-wort was higher in the control plot initially and increased during the summer, while in the treatment plot, pre-

treatment densities were lower than the control plot and declined during the summer (Table 3-1).

The pre-treatment density of twistspine prickly pear cactus (*Opuntia macrorhiza*) was lower in the control plot (61.8 stems/m<sup>2</sup>) than in the treatment plot (78.8 stems/m<sup>2</sup>; Table 3-1). Both plots showed increases in the stem densities after treatment (65.4 stems/m<sup>2</sup> in the control plot, and 108.6 stems/m<sup>2</sup> in the treatment plot; Table 3-1), although the large increase in the treatment plot probably resulted from the higher visibility of those cactus plants, due to the chlorotic state induced by the herbicide. The pre-treatment density of the hedgehog cactus (*Echinocereus viridiflorus*) was also lower in the control plot (6.2 stems/m<sup>2</sup>) than in the treatment plot (19.6 stems/m<sup>2</sup>; Table 3-1). After treatment, the density of hedgehog cactus decreased slightly in the control plot (5.2 stems/m<sup>2</sup>) and increased in the treatment plot (22.2 stems/m<sup>2</sup>; Table 3-1).

#### 3.4.4 Frequency Data

After treatment, the quadrat frequency of diffuse knapweed declined by 20 percent in the treatment plot, while no change occurred in the control plot. A better evaluation of treatment effectiveness will be made in the next year's sampling, after the herbicide has had a chance to work. No other frequency results for other species are reported from this year; year-to-year comparisons and changes will be reported in next year's report.

### 3.5 DISCUSSION

Data from the first year of a multi-year study are reported herein, and constitute essentially baseline data. As mentioned previously, no statistical analyses were done this year, and because only a short time had passed from the time of herbicide application to post-treatment sampling, little change was expected. Also, the sampling method was such that if a plant grew during the current year, even if it was dead or partially dead during the second sampling session, it was still recorded as present and alive. Full comparisons of the pre- to post-treatment data from different years will be made in next year's study, after the herbicide application has had a year to take effect.

Preliminary analysis of the data revealed that the control and treatment plots were quite similar in terms of species richness and composition. Both plots were dominated by mountain muhly, Canada bluegrass, and big bluestem, and both contained a comparable variety of forbs. The density data revealed a large difference in diffuse knapweed density between the control and treatment areas, even though the areas appeared to be similar. The high number of rosettes and a more clumped distribution of the species in the treatment area probably accounted for much of the difference between the outward appearance and the density data. These factors will be taken into account when examining the 1998 data.

General observations recorded in field notes during the post-treatment sampling in the treatment area indicated that the herbicide application did have an impact on the diffuse knapweed. Although many of the diffuse knapweed plants had already bolted and were in the bud stage as the herbicide was applied, most of the plants in the treated area developed very few flowers and showed substantial wilting and chlorosis. In fact, many were dying by the time the post-treatment sampling occurred. The diffuse knapweed in the control plot showed none of these effects.

The herbicide treatment also had an impact on many of the native species. The following native species were observed with some signs of chlorosis, wilting, no flowering, or often death: twistspine prickly pear cacti, Porter's aster (*Aster porteri*), white sage (*Artemisia ludoviciana*), soft goldenrod (*Solidago mollis*), western sagewort (*Artemisia campestris*), blanket flower (*Gallardia aristata*), and dotted gayfeather (*Liatris punctata*). The non-native species curly-top gumweed and western ragweed (*Ambrosia psilostachya*) also showed some impact from the herbicide treatments.

In a study conducted on Boulder County Open Space (Murdock 1998, pers. comm.), similar effects were noted as a result of Tordon 22K application, but the native forbs rebounded. Sampling during 1998 will provide data to begin assessing the persistence of these impacts on the native species at the Site.

Monitoring in 1998 will enable more definitive assessment of impacts to specific species. As the study questions are answered, the effects of herbicide treatments on the xeric tall-grass prairie will be evaluated further, to ensure that the spread of diffuse knapweed on the Site is controlled with minimal impact to this rare plant community.

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







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**1997 Diffuse Knapweed  
(*Centaurea diffusa*)  
Monitoring Plot Locations  
Figure 3-1**

**MAP LEGEND**

**Standard Map Features**

-  DKC - Control Plot
-  DKT - Treatment Plot
-  Buildings and other structures
-  Solar evaporation ponds
-  Lakes and ponds
-  Streams, ditches, or other drainage features
-  Fences and other barriers
-  Camour (50-Foot)
-  Paved roads
-  Dirt roads

NOTES:  
1. Symbols for buildings, solar evaporation ponds, and lakes and ponds are approximate and are provided by the user of this map.



Scale = 1 : 25,200  
1 inch represents approximately 193 feet

0 100 200 ft

State Plane Coordinate Projection  
Colorado Central Zone  
Datum: NAD27

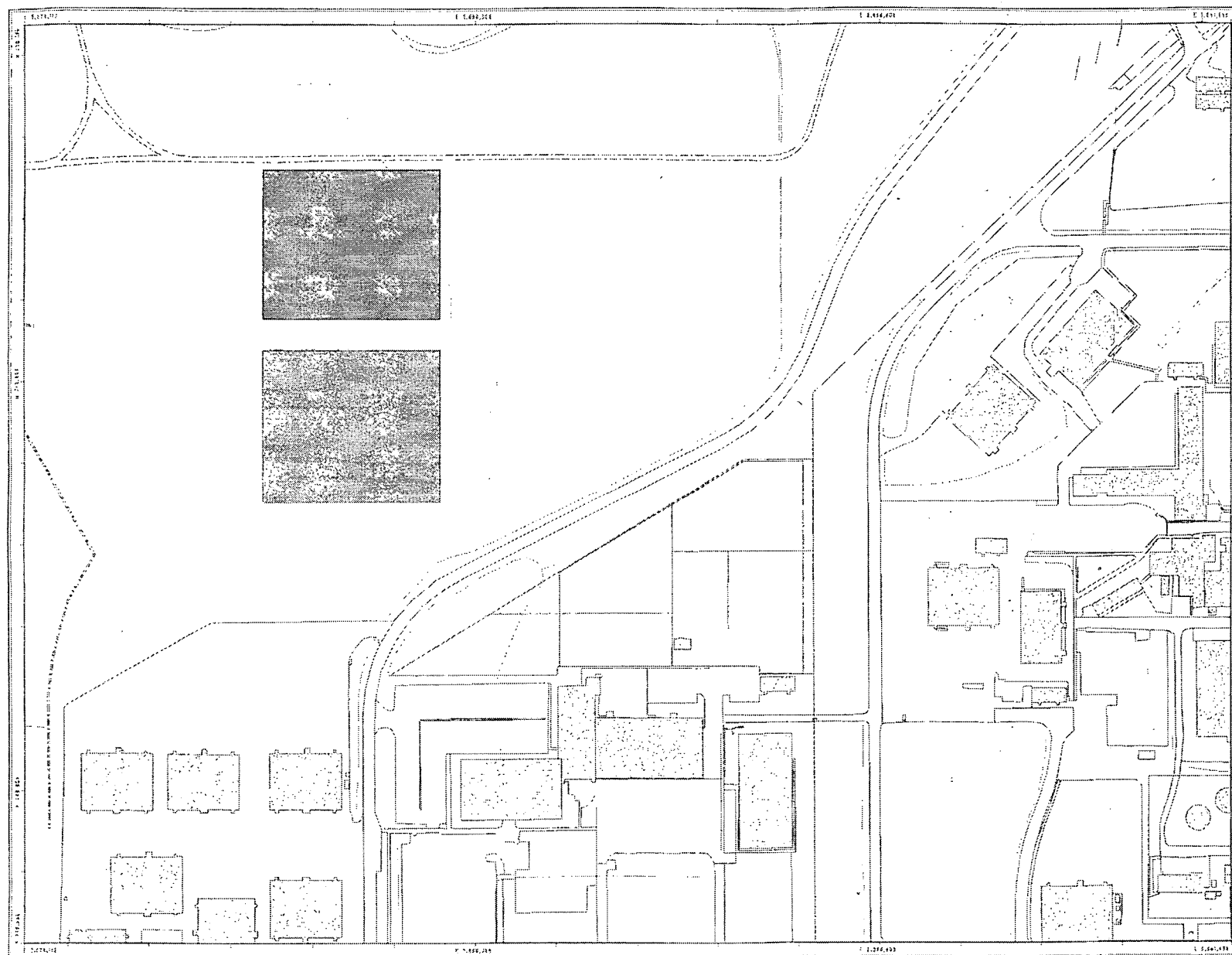
U. S. Department of Energy  
Rocky Flats Environmental Technology Site

Prepared by

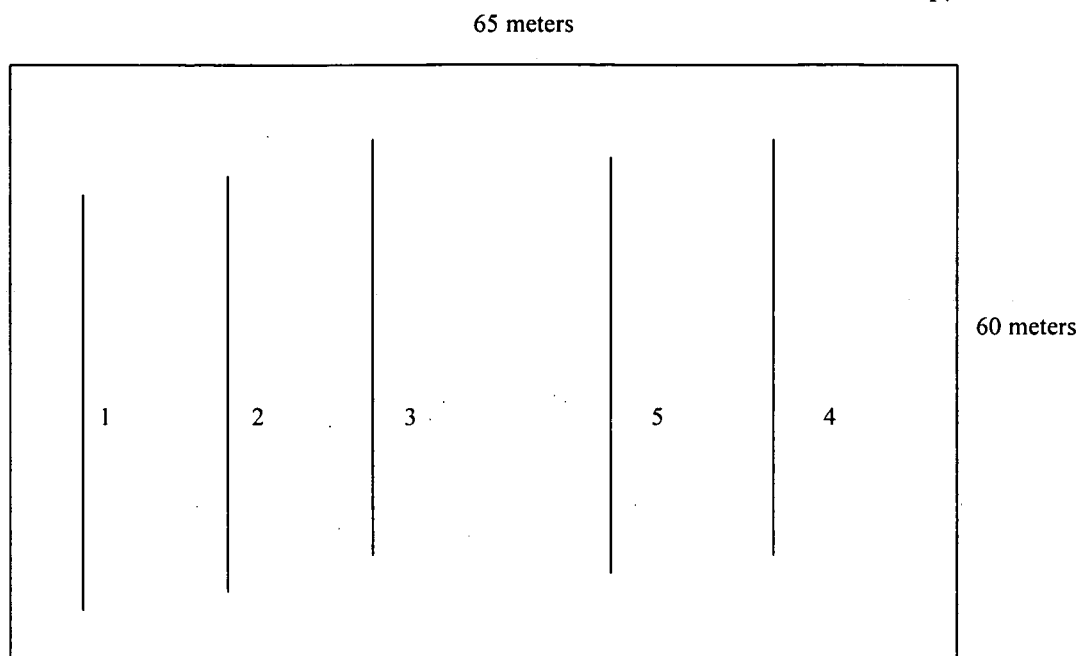
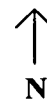
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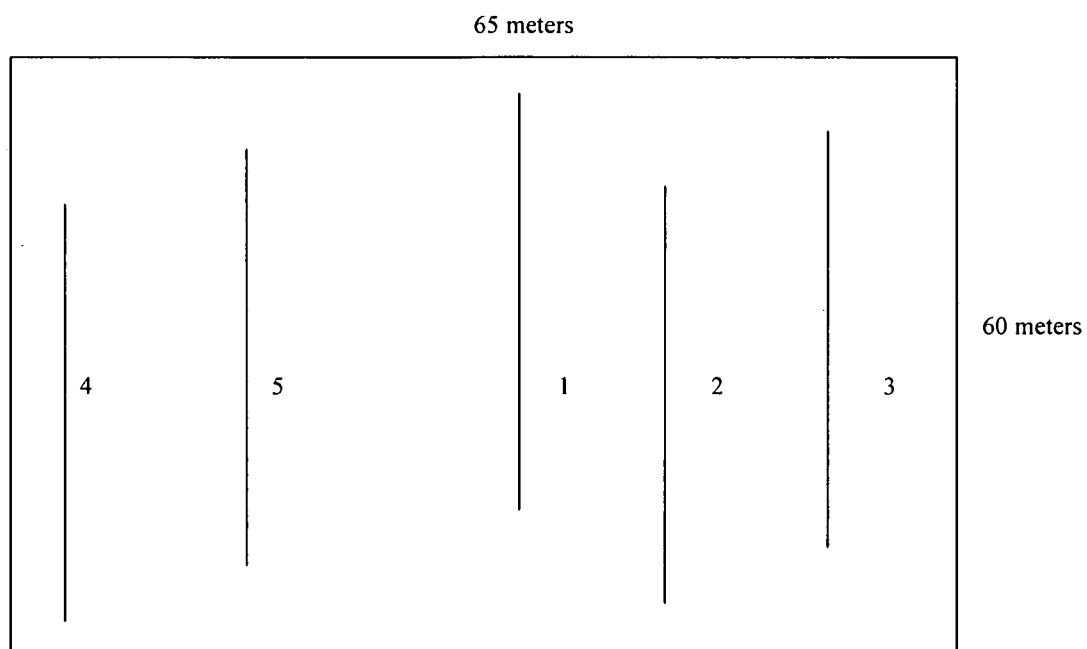
May 13, 1998



**Figure 3-2. Diffuse Knapweed Monitoring Plot and Transect Locations**



**Control Plot - DKC**



**Treatment Plot - DKT**

**TABLE 3-1. 1997 DIFFUSE KNAPWEED MONITORING DATA SUMMARY**

Variables	DKC - Control		DKT - Treatment	
	Spring97	Summer97	Spring97	Summer97
<b>Species Richness</b>				
Number of plant families	18	18	20	17
Number of species	68	65	74	62
Percent natives	75	74	73	77
Mean number of species/quadrat	13.84	12.8	12.24	10.08
<b>Mean Percent Cover</b>				
Total foliar cover	68.2	78.8	66.6	71
Total basal vegetation cover	10.8	8	10.8	10.2
Rock cover	12.8	12	19.8	17.4
Bare ground cover	11.6	4	9	5.4
Litter cover	64.8	76	60.4	67
Native foliar cover	69.2	65.99	67.57	71.55
Non-native foliar cover	30.79	34.01	32.43	28.45
<b>Weed Densities (mean # stems/m<sup>2</sup>)</b>				
Diffuse knapweed	5.56	3.64	22.96	6.12
Curly-top gumweed	1.68	1.28	1.36	1.2
St. John's-wort	0.84	1.28	0.6	0.28
<b>Cactus Densities (mean # stems/m<sup>2</sup>)</b>				
Twistspine prickly pear cactus	61.8	65.4	78.8	108.6
Hedgehog cactus	6.2	5.2	19.6	22.2

**TABLE 3-2. 1997 DIFFUSE KNAPWEED MONITORING SPECIES RICHNESS PRE- AND POST-TREATMENT  
FOR CONTROL AND TREATMENT PLOTS**

Family	Sciname	Speccode	Native	Spring DKC	Summer DKC	Spring DKT	Summer DKT
APIACEAE	Lomatium orientale Coult. & Rose	LOOR1	Y	X	X	X	X
ASCLEPIADACEAE	Asclepias stenophylla A. Gray	ASST1	Y	X	X	X	
ASCLEPIADACEAE	Asclepias viridiflora Raf.	ASVI1	Y	X	X	X	X
ASTERACEAE	Achillea millefolium L. ssp. lanulosa (Nutt.) Piper	ACMI1	Y	X	X	X	X
ASTERACEAE	Ambrosia psilostachya DC.	AMPS1	Y	X	X	X	X
ASTERACEAE	Antennaria parvifolia Nutt.	ANPA1	Y	X	X	X	X
ASTERACEAE	Arnica fulgens Pursh.	ARFU1	Y	X	X	X	X
ASTERACEAE	Artemisia campestris L. ssp. caudata (Michx.) Hall & Clem.	ARCA1	Y	X	X	X	X
ASTERACEAE	Artemisia frigida Willd.	ARFR1	Y			X	
ASTERACEAE	Artemisia ludoviciana Nutt. var. ludoviciana	ARLU1	Y	X	X	X	X
ASTERACEAE	Aster porteri Gray	ASPO1	Y	X	X	X	X
ASTERACEAE	Carduus nutans L. ssp. macrolepis (Peters.) Kazmi	CANU1	N	X	X	X	
ASTERACEAE	Centaurea diffusa Lam.	CED11	N	X	X	X	X
ASTERACEAE	Chrysopsis fulcrata Greene	CHFU1	Y	X	X	X	X
ASTERACEAE	Cirsium arvense (L.) Scop.	CIAR1	N			X	
ASTERACEAE	Erigeron divergens T. & G.	ERDI1	Y			X	X
ASTERACEAE	Erigeron flagellaris A. Gray	ERFL1	Y	X	X	X	X
ASTERACEAE	Gaillardia aristata Pursh.	GAAR1	Y	X	X	X	X
ASTERACEAE	Grindelia squarrosa (Pursh.) Dun.	GRSQ1	Y	X	X	X	X
ASTERACEAE	Lactuca serriola L.	LASE1	N	X	X	X	X
ASTERACEAE	Liatris punctata Hook.	LIPU1	Y	X	X	X	X
ASTERACEAE	Microseris cuspidata (Pursh.) Sch. Bip.	MICU1	Y	X		X	
ASTERACEAE	Scorzonera laciniata L.	SCLA1	N	X	X	X	X
ASTERACEAE	Senecio plattensis Nutt.	SEPL1	Y	X	X	X	X
ASTERACEAE	Senecio spartioides T. & G.	SESP1	Y				X
ASTERACEAE	Solidago mollis Bart.	SOMO1	Y	X	X	X	X
ASTERACEAE	Solidago rigida L.	SORI1	Y		X		
ASTERACEAE	Taraxacum officinale Weber	TAOF1	N	X	X	X	X
ASTERACEAE	Tragopogon dubius Scop.	TRDU1	N	X	X	X	X
BORAGINACEAE	Lithospermum incisum Lehm.	LIIN1	Y	X	X		
BORAGINACEAE	Mertensia lanceolata (Pursh.) A. DC.	MELA1	Y			X	
BRASSICACEAE	Alyssum alyssoides (L.) L.	ALAL1	N			X	
BRASSICACEAE	Alyssum minus (L.) Rothmaler var. micranthus (C. A. Mey.)	ALMI1	N	X	X	X	X
BRASSICACEAE	Arabis hirsuta (L.) Scop. var. pynocarpa (Hopkins) Rollins	ARHI1	Y			X	X
BRASSICACEAE	Barbarea vulgaris R. Br.	BAVU1	N			X	X
BRASSICACEAE	Camelina microcarpa Andr. ex DC.	CAMI1	N	X	X	X	
BRASSICACEAE	Draba reptans (Lam.) Fern.	DRRE1	Y	X	X		
BRASSICACEAE	Erysimum capitatum (Nutt.) DC.	ERCA2	Y	X	X	X	X
BRASSICACEAE	Lepidium campestre (L.) R. Br.	LECA1	N	X	X	X	X
BRASSICACEAE	Lepidium densiflorum Schrad.	LEDE1	Y	X	X	X	X
BRASSICACEAE	Lesquerella montana (A. Gray) Wats.	LEMO1	Y	X	X	X	X
BRASSICACEAE	Sisymbrium altissimum L.	SIAL1	N	X	X		
CACTACEAE	Coryphantha missouriensis (Sweet) Britt. & Rose	COMI1	Y	X		X	
CACTACEAE	Echinocereus viridiflorus Engelm.	ECVI1	Y	X	X	X	X
CACTACEAE	Opuntia macrorhiza Engelm.	OPMA1	Y	X	X	X	X
CARYOPHYLLACEAE	Arenaria fendleri A. Gray	ARFE2	Y	X	X	X	X
CARYOPHYLLACEAE	Paronychia jamesii T. & G.	PAJA1	Y	X		X	X
CARYOPHYLLACEAE	Silene antirrhina L.	SIAN1	Y	X	X	X	X
CLUSIACEAE	Hypericum perforatum L.	HYPE1	N	X	X	X	X
COMMELINACEAE	Tradescantia occidentalis (Britt.) Smyth	TROC1	Y	X		X	

TABLE 3-2. (cont.)

Family	Sciname	Speccode	Native	Spring DKC	Summer DKC	Spring DKT	Summer DKT
CRASSULACEAE	<i>Sedum lanceolatum</i> Torr.	SELA1	Y			X	X
CYPERACEAE	<i>Carex heliophila</i> Mack.	CAHE1	Y	X	X	X	X
CYPERACEAE	<i>Eleocharis compressa</i> Sulliv.	ELCO1	Y	X	X	X	X
FABACEAE	<i>Dalea purpurea</i> Vent	DAPU1	Y	X	X	X	X
FABACEAE	<i>Medicago lupulina</i> L.	MELU1	N			X	
FABACEAE	<i>Oxytropis lambertii</i> Pursh.	OXLA1	Y	X			
FABACEAE	<i>Psoralea tenuiflora</i> Pursh.	PSTE1	Y	X	X	X	X
HYDROPHYLLACEAE	<i>Phacelia heterophylla</i> Pursh.	PHHE1	Y				X
JUNCACEAE	<i>Juncus interior</i> Wieg.	JUIN1	Y		X		
LILIACEAE	<i>Allium textile</i> A. Nels. & Macbr.	ALTE1	Y	X	X	X	X
LILIACEAE	<i>Leucocrinum montanum</i> Nutt.	LEMO2	Y	X			
ONAGRACEAE	<i>Oenothera villosa</i> Thunb. ssp. strigosa (Rydb.) Dietrich &	OEVI1	Y	X	X		
OROBANCHACEAE	<i>Orobanche fasciculata</i> Nutt.	ORFA1	Y	X			X
PLANTAGINACE	<i>Plantago lanceolata</i> L.	PLLA1	N	X	X	X	X
PLANTAGINACE	<i>Plantago patagonica</i> Jacq.	PLPA1	Y			X	
POACEAE	<i>Agropyron smithii</i> Rydb.	AGSM1	Y	X			
POACEAE	<i>Andropogon gerardii</i> Vitman	ANGE1	Y	X	X	X	X
POACEAE	<i>Andropogon scoparius</i> Michx.	ANSC1	Y	X	X	X	X
POACEAE	<i>Aristida purpurea</i> Nutt. var. robusta (Merrill) A. Holmgren	ARLO1	Y		X		
POACEAE	<i>Bouteloua curtipendula</i> (Michx.) Torr.	BOCU1	Y	X	X	X	X
POACEAE	<i>Bouteloua gracilis</i> (H. B. K.) Lag ex Griffiths	BOGR1	Y	X	X	X	X
POACEAE	<i>Bouteloua hirsuta</i> Lag	BOHI1	Y	X	X	X	X
POACEAE	<i>Bromus inermis</i> Leyss. ssp. inermis	BRIN1	N	X	X		
POACEAE	<i>Bromus japonicus</i> Thunb. ex Murr.	BRJA1	N	X	X	X	X
POACEAE	<i>Bromus tectorum</i> L.	BRTE1	N			X	X
POACEAE	<i>Buchloe dactyloides</i> (Nutt.) Engelm.	BUDA1	Y			X	X
POACEAE	<i>Koeleria pyramidata</i> (Lam.) Beauv.	KOPY1	Y	X	X	X	X
POACEAE	<i>Muhlenbergia montana</i> (Nutt.) Hitchc.	MUMO1	Y	X	X	X	X
POACEAE	<i>Poa compressa</i> L.	POCO1	N	X	X	X	X
POACEAE	<i>Poa pratensis</i> L.	POPR1	N	X	X	X	X
POACEAE	<i>Sitanion hystrix</i> (Nutt.) Sm. var. brevifolium (Sm.) Hitchc	SIHY1	Y	X	X	X	X
POACEAE	<i>Sorghastrum nutans</i> (L.) Nash	SONU1	Y		X		X
POACEAE	<i>Sporobolus heterolepis</i> (A. Gray) A. Gray	SPHE1	Y	X	X	X	X
POLEMONIACEAE	<i>Collomia linearis</i> Nutt.	COLI1	Y			X	
POLYGONACEAE	<i>Eriogonum alatum</i> Torr.	ERAL1	Y			X	X
POLYGONACEAE	<i>Rumex crispus</i> L.	RUCR1	N			X	
PORTULACACEAE	<i>Talinum parviflorum</i> Nutt.	TAPA1	Y		X	X	
ROSACEAE	<i>Potentilla gracilis</i> Dougl. ex Hook. var. glabrata (Lehm.)	POGR1	Y			X	
ROSACEAE	<i>Prunus virginiana</i> L. var. melanocarpa (A. Nels.) Sarg.	PRVI1	Y	X	X		
SCROPHULARIACEAE	<i>Penstemon virens</i> Penn.	PEVI1	Y	X	X	X	X
SCROPHULARIACEAE	<i>Verbascum blattaria</i> L.	VEBL1	N	X	X		

Spring DKC = Spring Control Plot

Summer DKC = Summer Control Plot

Spring DKT = Spring Treatment Plot

Summer DKT = Summer Treatment Plot

**TABLE 3-3. 1997 PRE-TREATMENT FOLIAR AND BASAL COVER AMOUNTS  
AT CONTROL AND TREATMENT PLOTS**

Sample Site	Scientific Name	Native	Mean # Basal Hits	Mean Absolute Foliar Cover	Mean Relative Foliar Cover	Frequency
DKC	Muhlenbergia montana (Nutt.) Hitchc.	Y	3.6	23.2	34.02	100
DKC	Poa compressa L.	N	3.4	17.2	25.22	100
DKC	Andropogon gerardii Vitman	Y	1.4	8.6	12.61	100
DKC	Sporobolus heterolepis (A. Gray) A. Gray	Y	1.2	5.6	8.21	100
DKC	Aster porteri Gray	Y	0.2	2.6	3.81	100
DKC	Centaurea diffusa Lam.	N		2.6	3.81	100
DKC	Ambrosia psilostachya DC.	Y		1.2	1.76	60
DKC	Artemisia ludoviciana Nutt. var. ludoviciana	Y		1	1.47	100
DKC	Psoralea tenuiflora Pursh.	Y		0.8	1.17	40
DKC	Carex heliophila Mack.	Y	0.2	0.6	0.88	60
DKC	Poa pratensis L.	N		0.4	0.59	20
DKC	Tragopogon dubius Scop.	N		0.4	0.59	40
DKC	Lepidium campestre (L.) R. Br.	N		0.4	0.59	20
DKC	Koeleria pyramidata (Lam.) Beauv.	Y		0.4	0.59	40
DKC	Grindelia squarrosa (Pursh.) Dun.	Y	0.2	0.4	0.59	40
DKC	Andropogon scoparius Michx.	Y	0.2	0.4	0.59	20
DKC	Bouteloua gracilis (H. B. K.) Lag ex Griffiths	Y		0.4	0.59	20
DKC	Bouteloua curtipendula (Michx.) Torr.	Y		0.4	0.59	40
DKC	Arenaria fendleri A. Gray	Y		0.4	0.59	40
DKC	Eleocharis compressa Sulliv.	Y	0.2	0.4	0.59	20
DKC	Liatris punctata Hook.	Y		0.2	0.29	20
DKC	Arnica fulgens Pursh.	Y		0.2	0.29	20
DKC	Asclepias stenophylla A. Gray	Y		0.2	0.29	20
DKC	Silene antirrhina L.	Y		0.2	0.29	20
DKC	Bare Ground		11.6			100
DKC	Rock		12.8			100
DKC	Litter		64.8			100
DKC	Opuntia macrorhiza Engelm.	Y				40
DKC	Bouteloua hirsuta Lag	Y	0.2			20
DKT	Muhlenbergia montana (Nutt.) Hitchc.	Y	5	26.4	39.64	100
DKT	Poa compressa L.	N	3	12.2	18.32	100
DKT	Andropogon gerardii Vitman	Y	1	5	7.51	80
DKT	Centaurea diffusa Lam.	N	0.2	4.4	6.61	100
DKT	Bromus japonicus Thunb. ex Murr.	N		2.2	3.30	60
DKT	Aster porteri Gray	Y	0.2	2	3.00	80
DKT	Bromus tectorum L.	N		1.8	2.70	20
DKT	Sporobolus heterolepis (A. Gray) A. Gray	Y		1.6	2.40	60
DKT	Andropogon scoparius Michx.	Y		1.6	2.40	80

TABLE 3-3. (cont.)

Sample Site	Scientific Name	Native	Mean # Basal Hits	Mean Absolute Foliar Cover	Mean Relative Foliar Cover	Frequency
DKT	Ambrosia psilostachya DC.	Y	0.4	1.6	2.40	80
DKT	Bouteloua curtipendula (Michx.) Torr.	Y		0.8	1.20	60
DKT	Lomatium orientale Coult. & Rose	Y		0.8	1.20	60
DKT	Carex heliophila Mack.	Y		0.8	1.20	60
DKT	Bouteloua hirsuta Lag	Y		0.8	1.20	80
DKT	Bouteloua gracilis (H. B. K.) Lag ex Griffiths	Y	0.4	0.6	0.90	40
DKT	Grindelia squarrosa (Pursh.) Dun.	Y		0.6	0.90	60
DKT	Arnica fulgens Pursh.	Y		0.6	0.90	60
DKT	Artemisia ludoviciana Nutt. var. ludoviciana	Y		0.4	0.60	20
DKT	Arenaria fendleri A. Gray	Y		0.4	0.60	20
DKT	Liatris punctata Hook.	Y		0.2	0.30	20
DKT	Poa pratensis L.	N		0.2	0.30	20
DKT	Opuntia macrorhiza Engelm.	Y		0.2	0.30	40
DKT	Plantago lanceolata L.	N	0.2	0.2	0.30	20
DKT	Lepidium campestre (L.) R. Br.	N		0.2	0.30	20
DKT	Allium textile A. Nels. & Macbr.	Y	0.2	0.2	0.30	20
DKT	Hypericum perforatum L.	N		0.2	0.30	20
DKT	Asclepias stenophylla A. Gray	Y		0.2	0.30	20
DKT	Tragopogon dubius Scop.	N		0.2	0.30	20
DKT	Koeleria pyramidata (Lam.) Beauv.	Y	0.2	0.2	0.30	40
DKT	Lepidium densiflorum Schrad.	Y				20
DKT	Litter		60.4			100
DKT	Bare Ground		9			100
DKT	Rock		19.8			100

DKC = Control Plot, DKT = Treatment Plot

TABLE 3-4. 1997 POST-TREATMENT FOLIAR AND BASAL COVER AMOUNTS AT CONTROL AND TREATMENT PLOTS

Sample Site	Scientific Name	Native	Mean # Basal Hits	Mean Absolute Foliar Cover	Mean Relative Foliar Cover	Frequency
DKC	Muhlenbergia montana (Nutt.) Hitchc.	Y	2.6	24.4	30.96	100
DKC	Poa compressa L.	N	3	20.8	26.40	100
DKC	Andropogon gerardii Vitman	Y	0.6	11	13.96	100
DKC	Sporobolus heterolepis (A. Gray) A. Gray	Y	1	6.2	7.87	100
DKC	Centaurea diffusa Lam.	N	0.2	4.8	6.09	100
DKC	Aster porteri Gray	Y		2	2.54	100
DKC	Bouteloua curtipendula (Michx.) Torr.	Y	0.2	1.8	2.28	80
DKC	Carex heliophila Mack.	Y		1.6	2.03	100
DKC	Psoralea tenuiflora Pursh.	Y		1.4	1.78	80
DKC	Grindelia squarrosa (Pursh.) Dun.	Y		1.2	1.52	80
DKC	Ambrosia psilostachya DC.	Y		0.6	0.76	60
DKC	Poa pratensis L.	N	0.2	0.6	0.76	40
DKC	Sitanion hystrix (Nutt.) Sm. var. brevifolium (Sm.) Hitchc.	Y		0.2	0.25	20
DKC	Lepidium campestre (L.) R. Br.	N		0.2	0.25	20
DKC	Koeleria pyramidata (Lam.) Beauv.	Y		0.2	0.25	20
DKC	Hypericum perforatum L.	N		0.2	0.25	20
DKC	Tragopogon dubius Scop.	N		0.2	0.25	20
DKC	Erigeron flagellaris A. Gray	Y		0.2	0.25	20
DKC	Dalea purpurea Vent	Y		0.2	0.25	20
DKC	Asclepias stenophylla A. Gray	Y		0.2	0.25	20
DKC	Artemisia ludoviciana Nutt. var. ludoviciana	Y		0.2	0.25	20
DKC	Arenaria fendleri A. Gray	Y		0.2	0.25	20
DKC	Andropogon scoparius Michx.	Y		0.2	0.25	20
DKC	Gaillardia aristata Pursh.	Y		0.2	0.25	20
DKC	Bare Ground		4			100
DKC	Eleocharis compressa Sulliv.	Y	0.2			20
DKC	Opuntia macrorhiza Engelm.	Y				40
DKC	Rock		12			100
DKC	Litter		76			100
DKT	Muhlenbergia montana (Nutt.) Hitchc.	Y	5.4	35.2	49.58	100
DKT	Poa compressa L.	N	4	12.4	17.46	100
DKT	Andropogon gerardii Vitman	Y	0.4	8.2	11.55	100
DKT	Centaurea diffusa Lam.	N		4.8	6.76	100
DKT	Bromus japonicus Thunb. ex Murr.	N		2.4	3.38	80
DKT	Aster porteri Gray	Y	0.4	2	2.82	100
DKT	Carex heliophila Mack.	Y		1.2	1.69	40
DKT	Artemisia ludoviciana Nutt. var. ludoviciana	Y		1	1.41	60
DKT	Andropogon scoparius Michx.	Y		1	1.41	60
DKT	Sporobolus heterolepis (A. Gray) A. Gray	Y		0.6	0.85	20
DKT	Poa pratensis L.	N		0.4	0.56	20
DKT	Bouteloua curtipendula (Michx.) Torr.	Y		0.4	0.56	40

TABLE 3-4. (cont.)

Sample Site	Scientific Name	Native	Mean # Basal Hits	Mean Absolute Foliar Cover	Mean Relative Foliar Cover	Frequency
DKT	<i>Hypericum perforatum</i> L.	N		0.2	0.28	20
DKT	<i>Dalea purpurea</i> Vent	Y		0.2	0.28	20
DKT	<i>Koeleria pyramidata</i> (Lam.) Beauv.	Y		0.2	0.28	20
DKT	<i>Bouteloua gracilis</i> (H. B. K.) Lag ex Griffiths	Y		0.2	0.28	20
DKT	<i>Grindelia squarrosa</i> (Pursh.) Dun.	Y		0.2	0.28	20
DKT	<i>Allium textile</i> A. Nels. & Macbr.	Y		0.2	0.28	20
DKT	<i>Arnica fulgens</i> Pursh.	Y		0.2	0.28	20
DKT	Litter		67			100
DKT	<i>Echinocereus viridiflorus</i> Engelm.	Y				20
DKT	<i>Opuntia macrorhiza</i> Engelm.	Y				80
DKT	Bare Ground		5.4			100
DKT	Rock		17.4			100

DKC = Control Plot, DKT = Treatment Plot

## Section 4

## 4. 1997 XERIC TALLGRASS PRAIRIE MONITORING

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During 1997, a multi-year study was begun to examine the effects of controlled burning on the xeric tallgrass prairie at the Rocky Flats Environmental Technology Site (Site). The study began with an evaluation to assess pre-burn conditions on two treatment plots (the areas to be burned) and a control plot. The initial burn was not conducted, however, so this report contains the baseline findings of the 1997 monitoring.

### 4.1 BACKGROUND

Controlled burns were contemplated as a resource management tool at the Site because of concerns on two fronts: the spread of noxious weed species, and the danger of wildfires.

Several weed species have invaded the native plant communities at the Site. These species include diffuse knapweed (*Centaurea diffusa*), musk thistle (*Carduus nutans*), Canada thistle (*Cirsium arvense*), dalmatian toadflax (*Linaria dalmatica*), curly-top gumweed (*Grindelia squarrosa*), and St. John's-wort (*Hypericum perforatum*). Other non-native graminoid species, such as Japanese brome (*Bromus japonicus*), downy brome (*Bromus tectorum*), and smooth brome (*Bromus inermis*), are also dominant species in some communities. In addition, the health and vigor of many of the native plant species, such as big bluestem (*Andropogon gerardii*), little bluestem (*Andropogon scoparius*), mountain muhly (*Muhlenbergia montana*), needle-and-thread grass (*Stipa comata*), junegrass (*Koeleria pyramidata*), blue grama (*Bouteloua gracilis*), western wheatgrass (*Agropyron smithii*), and side oats grama (*Bouteloua curtipendula*), have been weakened by litter buildup, lowered nutrient recycling, and lack of grazing and fire in the grassland communities at the Site.

In response to these concerns, the feasibility of using controlled burns was investigated, and a multi-year study was designed to conduct controlled burns in 1998 and 2000 at some study plots, with the first pre-burn evaluation in 1997 and post-burn monitoring through 2002. The study was designed to monitor the effects of burning on both noxious weeds and native species in the Site's xeric tallgrass prairie by comparing treatment (burned) and control (unburned) plots before and after burning. The initial burns were not conducted, however, so this report provides the results of the 1997 monitoring. Species richness, cover, frequency, and density were summarized to examine differences among the plots and to compare the data to information gathered previously at other locations in the xeric tallgrass prairie at the Site.

## 4.2 METHODS

The locations of the control plot and two treatment plots are shown in Figure 4-1. The plots were located in the southwestern portion of the Buffer Zone in the xeric tallgrass prairie, west of the Antelope Springs area.<sup>3</sup> The two treatment plots were located west of Antelope Springs and were surrounded by firebreak roads on three sides. The control plot was located south of the treatment plots across the firebreak road.

As is typical of the Site's xeric tallgrass prairie, the study area was dominated by mountain muhly, big bluestem, Canada bluegrass, little bluestem, and needle-and-thread grass. Circular disturbed patches (mounds) in the study area were believed to have been created by northern pocket gophers (*Thomomys talpoides*), based on a study conducted nearby by Branson et al. (1965). These disturbed patches are common across much of the xeric tallgrass prairie at the Site, and they are distinguished as slightly elevated (15–20 cm) mounds, approximately 8 to 10 m in diameter, with cheatgrass and other adventive species commonly growing on them.

The original study plan called for controlled burns to be conducted in the two treatment plots, once in treatment plot 1 (in 1998) and twice in treatment plot 2 (in 1998 and 2000). The control plot would remain unburned throughout the duration of the study. Plot size was 80×80 m, with a minimum of 10 m between plots. All plots were located at least 5 m from the main roads. The stratified sampling design (Gauch 1982) used five replicate transects within each plot. The transects were each 50 m long, and were located at random within the boundaries of each plot. Transects were set up in an east/west direction, a minimum of 3 m apart.

Species richness<sup>4</sup> was determined by recording all the species found rooted within a 2-m-wide belt centered along a transect (50×2 m=100 m<sup>2</sup>). Within each transect, woody plant stem and cactus densities were counted by species. Foliar and basal cover by species was determined using a point-intercept method along each transect (100 points/transect). Litter, rock, and bare ground cover were also measured concurrently with the point-intercept method. Weed species densities for the target species were counted in five 1-m<sup>2</sup> quadrats (square shape) located at random along each 50-m transect. Weed species densities were counted in quadrats, in addition to cover sampling, to provide another measure of the abundance of the weed species. This approach was necessary, because the point-intercept sampling method tends to provide the best information for the species that are most abundant in the plant community, whereas the less common species are encountered infrequently using this method. Native species densities were not measured. Frequency data were gathered by recording the presence of all species encountered in each 1-m<sup>2</sup> quadrat. Specific methods are found in the *Environmental Monitoring Department Operating Procedures Manual* (DOE 1995a) and the *High-Value Vegetation Survey Plan for the Rocky Flats Environmental Technology Site* (K-H 1997a).

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<sup>3</sup> The grassland wildfire that occurred in the fall of 1996 at the Site burned an area east of the treatment plot locations on the pediment and hillsides.

Differences between the control and treatment plots were not evaluated statistically, because no controlled burn was conducted. Instead, species richness, cover, frequency, and density were summarized, to examine differences among the plots and to compare the data to information gathered previously at other locations in the xeric tallgrass prairie at the Site.

Species richness data were summarized by generating a species list for the control plot and treatment plots. A Sorenson coefficient of similarity index (Brower and Zar 1977) was used to evaluate the species richness similarity between the control and treatment plots. In addition, other species richness variables were calculated from the species lists.

Basal cover data were reported as total mean percent cover of vegetation, litter, rock, and bare ground. Foliar cover data were reported as frequency, relative cover, and absolute cover for each species encountered. Frequency from the cover data was defined as the percent of point-intercept transects on which a species occurred, out of the possible five sampled in each plot. Mean absolute foliar cover was the percentage of the number of hits on a species out of the total number of hits possible at a plot (500). Mean relative foliar cover was the number of hits for a species relative to the total number of vegetative hits recorded per plot (i.e., the percent of vegetative cover represented by the species). Frequency based on quadrats ( $n = 25$ ) was defined as the number of quadrats in which a species was recorded divided by 25 (the total number of quadrats possible), multiplied by 100. Density count data were summarized as the mean number of stems per square meter.

### 4.3 RESULTS

Species richness varied from 77 to 89 species recorded in each plot in 1997 (Table 4-1). The percentage of native species was essentially the same in all plots (84–86 percent; Table 4-1). The similarity of species in all three plots was also equally high, with Sorenson coefficient of similarity index values ranging from 0.80 to 0.82 for all possible comparisons between plots (Table 4-2). Table 4-3 shows the species recorded in each plot.

Total absolute foliar cover ranged from a mean of 75.8 percent in treatment plot 1 to a mean of 80.2 percent in the control plot (Table 4-4). The control plot had the highest amount of native relative foliar cover (82.5 percent), and treatment plots 1 and 2 had 68.1 percent and 75.5 percent, respectively (Table 4-3). The top three species in terms of mean relative foliar cover in all three plots were mountain muhly, big bluestem, and Canada bluegrass, in that order, except that big bluestem and Canada bluegrass were switched in order in treatment plot 1 (Table 4-4). The noxious diffuse knapweed provided less than 3 percent mean relative foliar cover in each plot (Table 4-4). Basal cover for vegetation, litter, rock, and bare ground revealed little difference between the plots (Table 4-5). Mean litter cover ranged from 73 to 75 percent in all three plots, and both basal vegetation and rock cover accounted for means of approximately 12 and 10 percent of the remainder of

the ground cover, respectively (Table 4-5). Bare ground made up less than 5 percent of the ground cover in all the plots (Table 4-5). Frequency data for all three plots are presented in Table 4-6, which shows spring and summer frequencies and the difference between the two sampling periods within each plot.

Density results for specific weed species and all cacti are presented in Tables 4-7 and 4-8. Diffuse knapweed was present in all three plots but had the highest density (mean 1.12 plants/m<sup>2</sup>) in treatment plot 1 (Table 4-7). Dalmatian toadflax density was highest in the control plot (mean 3.12 plants/m<sup>2</sup>), followed by treatment plot 2 (mean 2.04 plants/m<sup>2</sup>; Table 4-7); it was not recorded in treatment plot 1. St. John's-wort had the highest density in treatment plot 2 (mean 2.48 plants/m<sup>2</sup>), and less than half this amount was recorded in the control plot and treatment plot 1 (Table 4-7). Curly-top gumweed was also present in all three plots, with the highest density recorded in treatment plot 2 (Table 4-7). Musk thistle was recorded only in the quadrats in treatment plot 2, at a mean density of 0.12 plants/m<sup>2</sup> (Table 4-7).

The mean density of twistspine prickly pear cactus was higher than that of hedgehog cactus across all plots (Table 4-8; cacti density data are from the spring sampling). Mean cacti densities for both of these species were higher in the treatment plots than in the control plot (Table 4-8).

#### 4.4 CONCLUSIONS

From 1993 through 1995, two xeric tallgrass prairie sites (TR01 and TR12, located in the northwest and southwest corners of the Buffer Zone, respectively) were monitored by the Site's Ecological Monitoring Program (EcMP). The 1995 data from TR01 and TR12 were chosen to compare to the 1997 xeric tallgrass prairie plot locations (K-H 1997b). The methodologies used for the belt transects and point-intercept transects were the same for all sampling efforts, so direct comparisons of the results are valid. No comparisons of quadrat frequency or quadrat density data are possible, however, because these methods were not used at the EcMP sites.

In general, the total species richness and percentage of native species from the EcMP sites were very similar to those in the three 1997 xeric tallgrass prairie plots. TR01 and TR12 had 90 and 83 species, respectively, in 1995, with 86 percent and 81 percent, respectively, of those being native species (K-H 1997b). With respect to basal cover, the EcMP sites had 3–5 percent more mean basal vegetation cover, approximately twice as much mean rock cover, and 15–20 percent less mean litter cover than the 1997 xeric tallgrass prairie plots (K-H 1997b), which would suggest that the EcMP sites have greater potential for erosion than the 1997 xeric tallgrass prairie plot locations. Mean absolute foliar cover was somewhat lower at the 1997 xeric tallgrass prairie plots than the EcMP sites, by amounts ranging from 4 to 13 percent, but this was within the range of variability observed at TR01 and TR12 during the 3 years they were sampled (K-H 1997b).

The amount of native relative foliar cover across the 1997 xeric tallgrass prairie plots differed by more than 15 percent between the control plot and treatment plot 1 (Table 4-3), potentially indicating a weed problem in treatment plot 1. However, an examination of the cover amounts provided by individual species at treatment plot 1 revealed that nearly all the difference in non-native cover between the control plot and treatment plot 1 was due to the high cover of Canada bluegrass in treatment plot 1 (Table 4-3). Although Canada bluegrass is a non-native species, it is generally not considered an aggressive species that requires control. It is found quite commonly along the mesas and foothills in the Boulder area.

The mean relative foliar cover amounts for the dominant species at the 1997 xeric tallgrass prairie plot locations provide further evidence of the differences in dominant species across what is classified as the xeric tallgrass prairie on Site. As has been pointed out previously from EcMP site data (K-H 1997b; DOE 1995b), the dominant species at TR01 differed somewhat from those at TR12. Mean relative foliar graminoid cover at TR12 in 1995 consisted primarily of needle-and-thread grass (34.8 percent), big bluestem (13.2 percent), and Canada bluegrass (5.8 percent), while at TR01, mean relative foliar graminoid cover was primarily big bluestem (10.6 percent), Canada bluegrass (9.0 percent), mountain muhly (8.8 percent), needle-and-thread grass (8.8 percent), and little bluestem (5.4 percent; K-H 1997b). Little bluestem and mountain muhly each accounted for less than 1 percent of the mean relative foliar graminoid cover at TR12 in 1995. At the 1997 xeric tallgrass prairie plot locations, the dominant graminoid species, based on mean relative foliar cover, were mountain muhly (23.8–33.2 percent), big bluestem (13.7–22.0 percent), Canada bluegrass (8.2–24.5 percent), and Kentucky bluegrass (3.7–6.7 percent; Table 4-3).

The 1997 xeric tallgrass prairie plot results are similar to those found at the plots studied during the 1997 diffuse knapweed control study (see Section 3). The diffuse knapweed plots are between the TR01 site and the 1997 xeric tallgrass prairie plots. The dominant graminoid species, based on mean relative foliar cover, were also mountain muhly (34.0–39.6 percent), Canada bluegrass (18.3–25.2 percent), and big bluestem (7.5–12.6 percent). The differences in the amount of cover provided by these species at the various locations indicate that different plant associations, or variations of plant associations, are present across the on-Site areas of xeric tallgrass prairie. These differences probably reflect the variability in the soils and moisture availability, as well as the effects of past land management, grazing, fire, and other local disturbances.

In general, the results from the 1997 xeric tallgrass prairie monitoring plots fit well with data from other locations in the xeric tallgrass prairie at the Site. Should a controlled burn be scheduled in the future, these plots could be used for monitoring the effect of the fire on the native and weed species, and the 1997 data could be used as a baseline for evaluating pre- and post-burn conditions.

#### 4.5 REFERENCES

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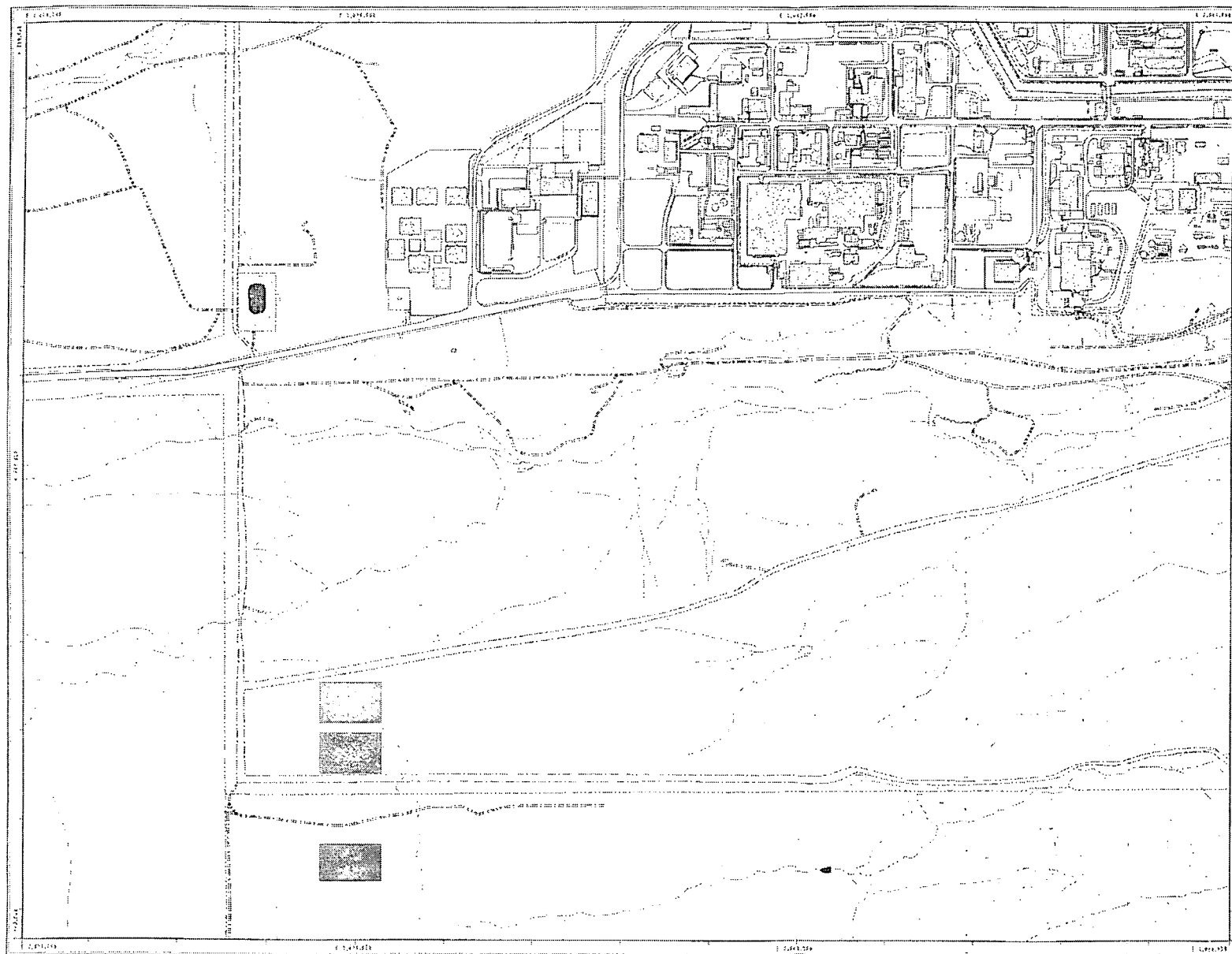
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**1997 Xeric Tallgrass Prairie  
Monitoring Plot Locations  
Figure 4-1**

### MAP LEGEND

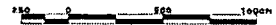
### Standard Map Features

- |   |  |
|---|--|
|  | BC1 - Control Plot                           |
|  | BT1 - Treatment Plot 1                       |
|  | BT2 - Treatment Plot 2                       |
|  | Buildings and other structures               |
|  | Solar evaporation ponds                      |
|  | Lakes and ponds                              |
|  | Gullies, ditches, or other drainage features |
|  | Fences and other barriers                    |
|  | Contour (20-Foot)                            |
|  | Paved roads                                  |
|  | Dirt roads                                   |

WITNESSES:  
The undersigned are attorneys and are  
competent to execute the foregoing deed.



Scale = 1 : 8000  
1 inch represents approximately 667 feet



State Plane Coordinate Projection  
Colorado Central Zone  
Datum: NAD27

**U.S. Department of Energy  
Rocky Flats Environmental Technology Site**

**Project**

Exponent

MAP ID: /h0cm07519556/

May 13, 1968

**TABLE 4-1. 1997 SPECIES RICHNESS SUMMARY INFORMATION  
FOR XERIC TALLGRASS PRAIRIE PLOTS**

Plot	# Families	# Species	% Native
BC1 - Control	22	77	86
BT1 - Treatment 1	24	89	84
BT2 - Treatment 2	23	86	84

**TABLE 4-2. SORENSON SIMILARITY COEFFICIENTS  
FROM SPECIES RICHNESS DATA AT  
XERIC TALLGRASS PRAIRIE PLOTS**

	BC1 - Control	BT1 - Treatment 1	BT2 - Treatment 2
BC1 - Control	-	0.80	0.82
BT1 - Treatment 1		-	0.82
BT2 - Treatment 2			-

TABLE 4-3. 1997 SPECIES RICHNESS AT XERIC TALLGRASS PRAIRIE PLOTS

Family	Scientific Name	Speccode	BC1 Control	BT1 Treatment1	BT2 Treatment 2
APIACEAE	Lomatium orientale Coult. & Rose	LOOR1	X	X	X
ASCLEPIADACEAE	Asclepias speciosa Torr.	ASSP1		X	X
ASCLEPIADACEAE	Asclepias stenophylla A. Gray	ASST1		X	X
ASCLEPIADACEAE	Asclepias viridiflora Raf.	ASVI1	X	X	X
ASTERACEAE	Achillea millefolium L. ssp. lanulosa (Nutt.) Piper	ACMI1	X	X	X
ASTERACEAE	Ambrosia psilostachya DC.	AMPS1	X	X	X
ASTERACEAE	Antennaria parvifolia Nutt.	ANPA1	X	X	X
ASTERACEAE	Arnica fulgens Pursh.	ARFU1		X	
ASTERACEAE	Artemisia campestris L. ssp. caudata (Michx.) Hall & Clem.	ARCA1	X	X	X
ASTERACEAE	Artemisia frigida Willd.	ARFR1	X	X	X
ASTERACEAE	Artemisia ludoviciana Nutt. var. ludoviciana	ARLU1	X	X	X
ASTERACEAE	Aster falcatus Lindl.	ASFA1		X	
ASTERACEAE	Aster porteri Gray	ASPO1	X	X	X
ASTERACEAE	Carduus nutans L. ssp. macrolepis (Peters.) Kazmi	CANU1		X	X
ASTERACEAE	Centaurea diffusa Lam.	CEDI1	X	X	X
ASTERACEAE	Chrysopsis fulcrata Greene	CHFUI	X	X	X
ASTERACEAE	Chrysopsis villosa Pursh.	CHVI1	X	X	X
ASTERACEAE	Cirsium undulatum (Nutt.) Spreng.	CIUN1	X	X	X
ASTERACEAE	Erigeron divergens T. & G.	ERDI1	X	X	X
ASTERACEAE	Erigeron flagellaris A. Gray	ERFL1	X	X	X
ASTERACEAE	Gaillardia aristata Pursh.	GAAR1	X	X	X
ASTERACEAE	Grindelia squarrosa (Pursh.) Dun.	GRSQ1	X	X	X
ASTERACEAE	Gutierrezia sarothrae (Pursh.) Britt. & Rusby	GUSA1			X
ASTERACEAE	Lactuca serriola L.	LASE1	X	X	X
ASTERACEAE	Liatris punctata Hook.	LIPU1	X	X	X
ASTERACEAE	Microseris cuspidata (Pursh.) Sch. Bip.	MICU1	X	X	X
ASTERACEAE	Ratibida columnifera (Nutt.) Woot. & Standl.	RACO1		X	X
ASTERACEAE	Senecio plattensis Nutt.	SEPL1	X	X	X
ASTERACEAE	Senecio spartioides T. & G.	SESP1		X	X
ASTERACEAE	Solidago mollis Bart.	SOMO1	X	X	X
ASTERACEAE	Taraxacum officinale Weber	TAOF1			X
ASTERACEAE	Tragopogon dubius Scop.	TRDU1	X	X	X
BORAGINACEAE	Lithospermum incisum Lehm.	LIIN1			X
BORAGINACEAE	Mertensia lanceolata (Pursh.) A. DC.	MELA1	X	X	X
BRASSICACEAE	Alyssum alyssoides (L.) L.	ALAL1			X
BRASSICACEAE	Alyssum minus (L.) Rothmaler var. micranthus (C. A. Mey.) Dudley	ALMI1	X	X	X
BRASSICACEAE	Arabis hirsuta (L.) Scop. var. pynocarpa (Hopkins) Rollins	ARHI1	X	X	X
BRASSICACEAE	Camelina microcarpa Andr. ex DC.	CAMI1		X	
BRASSICACEAE	Descurainia pinnata (Walt.) Britt.	DEPI1		X	
BRASSICACEAE	Draba reptans (Lam.) Fern.	DRRE1	X	X	X
BRASSICACEAE	Erysimum capitatum (Nutt.) DC.	ERCA2	X	X	X
BRASSICACEAE	Lepidium densiflorum Schrad.	LEDE1	X		
BRASSICACEAE	Lesquerella montana (A. Gray) Wats.	LEMO1	X	X	X
BRASSICACEAE	Sisymbrium altissimum L.	SIAL1	X	X	

TABLE 4-3. (cont.)

Family	Scientific Name	Speccode	BC1 Control	BT1 Treatment1	BT2 Treatment 2
CACTACEAE	Coryphantha missouriensis (Sweet) Britt. & Rose	COM1		X	
CACTACEAE	Echinocereus viridiflorus Engelm.	ECV1	X	X	X
CACTACEAE	Opuntia macrorhiza Engelm.	OPMA1	X	X	X
CARYOPHYLLACEAE	Arenaria fendleri A. Gray	ARFE2	X	X	X
CARYOPHYLLACEAE	Paronychia jamesii T. & G.	PAJA1	X	X	X
CARYOPHYLLACEAE	Silene antirrhina L.	SIAN1	X	X	X
CARYOPHYLLACEAE	Silene drummondii Hook.	SIDR1	X		X
CLUSIACEAE	Hypericum perforatum L.	HYPE1	X	X	X
COMMELINACEAE	Tradescantia occidentalis (Britt.) Smyth	TROC1		X	X
CRASSULACEAE	Sedum lanceolatum Torr.	SELA1	X		
CYPERACEAE	Carex eleocharis Bailey	CAEL1		X	
CYPERACEAE	Carex heliophila Mack.	CAHE1	X	X	X
CYPERACEAE	Eleocharis sp.	ELE1		X	
EUPHORBIACEAE	Euphorbia robusta (Engelm.) Small	EURO1		X	X
FABACEAE	Astragalus agrestis Dougl. ex G. Don	ASAG1	X	X	X
FABACEAE	Astragalus shortianus Nutt. ex T.&G.	ASSH1			X
FABACEAE	Dalea purpurea Vent	DAPU1	X	X	X
FABACEAE	Oxytropis lambertii Pursh.	OXLA1	X	X	X
FABACEAE	Psoralea tenuiflora Pursh.	PSTE1	X	X	X
HYDROPHYLLACEAE	Phacelia heterophylla Pursh.	PHHE1			X
JUNCACEAE	Juncus dudleyi Wieg.	JUDU1	X	X	
JUNCACEAE	Juncus interior Wieg.	JUIN1	X	X	
LAMIACEAE	Hedeoma hispidum Pursh.	HEHI1		X	
LILIACEAE	Allium georgii S. Wats.	ALGE1	X		
LILIACEAE	Allium textile A. Nels. & Macbr.	ALTE1	X	X	X
LILIACEAE	Leucocrinum montanum Nutt.	LEMO2	X	X	X
MALVACEAE	Sphaeralcea coccinea (Pursh.) Rydb.	SPCO1		X	X
NYCTAGINACEAE	Mirabilis linearis (Pursh.) Heimerl	MILI1		X	X
ONAGRACEAE	Calylophus serrulatus (Nutt.) Raven	CASE2	X		X
ONAGRACEAE	Gaura coccinea Pursh.	GACO1		X	
OROBANCHACEAE	Orobanche fasciculata Nutt.	ORFA1	X	X	X
POACEAE	Agropyron smithii Rydb.	AGSM1		X	X
POACEAE	Andropogon gerardii Vitman	ANGE1	X	X	X
POACEAE	Andropogon scoparius Michx.	ANSC1	X	X	X
POACEAE	Aristida purpurea Nutt. var. robusta (Merrill) A. Holmgren & N. Holmgr	ARLO1	X	X	X
POACEAE	Bouteloua curtipendula (Michx.) Torr.	BOCU1	X	X	X
POACEAE	Bouteloua gracilis (H. B. K.) Lag ex Griffiths	BOGR1	X	X	X
POACEAE	Bouteloua hirsuta Lag	BOHI1	X	X	X
POACEAE	Bromus japonicus Thunb. ex Murr.	BRJA1	X	X	X
POACEAE	Bromus tectorum L.	BRTE1	X	X	X
POACEAE	Koeleria pyramidata (Lam.) Beauv.	KOPY1	X	X	X
POACEAE	Muhlenbergia montana (Nutt.) Hitchc.	MUMO1	X	X	X
POACEAE	Muhlenbergia wrightii Vasey	MUWR1	X		
POACEAE	Poa canbyi (Scribn.) Piper	POCA1			X
POACEAE	Poa compressa L.	POCO1	X	X	X

TABLE 4-3. (cont.)

Family	Scientific Name	Speccode	BC1 Control	BT1 Treatment1	BT2 Treatment 2
POACEAE	Poa pratensis L.	POPR1	X	X	X
POACEAE	Sitanion hystrix (Nutt.) Sm. var. brevifolium (Sm.) Hitchc.	SIHY1	X	X	X
POACEAE	Sorghastrum nutans (L.) Nash	SONU1	X	X	X
POACEAE	Sporobolus asper (Michx.) Kunth	SPAS1		X	
POACEAE	Sporobolus cryptandrus (Torr.) A. Gray	SPCR1			X
POACEAE	Sporobolus heterolepis (A. Gray) A. Gray	SPHE1	X	X	X
POACEAE	Stipa comata Trin. & Rupr.	STCO1	X	X	X
POLEMONIACEAE	Ipomopsis spicata (Nutt.) V. Grant ssp. spicata	IPSP1	X		
POLYGONACEAE	Eriogonum alatum Torr.	ERAL1	X	X	X
POLYGONACEAE	Polygonum convolvulus L.	POCO2		X	
POLYGONACEAE	Polygonum sawatchense Small	POSA1	X	X	
PORTULACACEAE	Talinum parviflorum Nutt.	TAPA1		X	
RANUNCULACEAE	Delphinium nuttalianum Pritz. ex Walpers	DENU1	X		X
SANTALACEAE	Comandra umbellata (L.) Nutt.	COUM1	X		
SCROPHULARIACEAE	Castilleja sessiliflora Pursh.	CASE3	X		X
SCROPHULARIACEAE	Linaria dalmatica (L.) Mill.	LIDA1	X		X
SCROPHULARIACEAE	Penstemon virens Penn.	PEVI1	X	X	X
SCROPHULARIACEAE	Verbascum blattaria L.	VEBL1			X
SCROPHULARIACEAE	Verbascum thapsus L.	VETH1		X	
VIOLACEAE	Viola nuttallii Pursh.	VINU1	X	X	X

TABLE 4-4. 1997 XERIC TALLGRASS PRAIRIE PLOTS FOLIAR COVER SUMMARY

Family	Scientific Name	Speccode	Native	BC1 - Control			BT1 - Treatment 1			BT2 - Treatment 2		
				%	Mean		%	Mean		%	Mean	
					F r e q u e n c y	% F o r b i s a l a r t i c u l t o v e r		F r e q u e n c y	% F o r b i s a l a r t i c u l t o v e r		R e l a t i v e	F r e q u e n c y
ASCLEPIADACEAE	Asclepias speciosa Torr.	ASSP1	Y							20	0.20	0.26
ASTERACEAE	Ambrosia psilostachya DC.	AMPS1	Y	80	2.00	2.49	60	1.00	1.32	60	1.00	1.28
ASTERACEAE	Artemisia campestris L. ssp. caudata (Michx.) Hall & Clem.	ARCA1	Y				20	0.20	0.26	60	0.60	0.77
ASTERACEAE	Artemisia frigida Willd.	ARFR1	Y				40	0.40	0.53	20	0.40	0.51
ASTERACEAE	Artemisia ludoviciana Nutt. var. ludoviciana	ARLU1	Y				40	0.40	0.53	20	0.20	0.26
ASTERACEAE	Aster porteri Gray	ASPO1	Y	80	3.00	3.74	60	0.80	1.06	100	2.20	2.81
ASTERACEAE	Centaurea diffusa Lam.	CEDI1	N	60	1.40	1.75	40	0.40	0.53	60	2.00	2.56
ASTERACEAE	Chrysopsis fulcrata Greene	CHFU1	Y	20	0.20	0.25	60	0.80	1.06	20	0.20	0.26
ASTERACEAE	Chrysopsis villosa Pursh.	CHVI1	Y	40	0.60	0.75				20	0.20	0.26
ASTERACEAE	Erigeron flagellaris A. Gray	ERFL1	Y				60	0.80	1.06	20	0.20	0.26
ASTERACEAE	Gaillardia aristata Pursh.	GAAR1	Y							20	0.20	0.26
ASTERACEAE	Grindelia squarrosa (Pursh.) Dun.	GRSQ1	Y				40	0.40	0.53	20	0.20	0.26
ASTERACEAE	Lactuca serriola L.	LASE1	N				20	0.20	0.26			
ASTERACEAE	Liatris punctata Hook.	LIPU1	Y	80	1.20	1.50	40	0.80	1.06	60	1.20	1.53
ASTERACEAE	Solidago mollis Bart.	SOMO1	Y	20	0.20	0.25						
ASTERACEAE	Tragopogon dubius Scop.	TRDU1	N	40	0.60	0.75				20	0.20	0.26
BRASSICACEAE	Alyssum minus (L.) Rothmaler var. micranthus (C. A. Mey.) Dudley	ALMI1	N				20	0.20	0.26	40	0.40	0.51
BRASSICACEAE	Erysimum capitatum (Nutt.) DC.	ERCA2	Y				20	0.20	0.26	20	0.20	0.26
BRASSICACEAE	Lesquerella montana (A. Gray) Wats.	LEMO1	Y	20	0.20	0.25	40	0.60	0.79	100	1.40	1.79
CARYOPHYLLACEAE	Arenaria fendleri A. Gray	ARFE2	Y	80	2.60	3.24	40	0.40	0.53	60	0.80	1.02
CLUSIACEAE	Hypericum perforatum L.	HYPE1	N	40	0.40	0.50				40	0.60	0.77
CYPERACEAE	Carex heliophila Mack.	CAHE1	Y	100	6.00	7.48	100	3.20	4.22	100	2.60	3.32
FABACEAE	Psoralea tenuiflora Pursh.	PSTE1	Y	20	0.40	0.50	40	0.40	0.53	40	0.80	1.02
POACEAE	Agropyron smithii Rydb.	AGSM1	Y							20	0.20	0.26
POACEAE	Andropogon gerardii Vitman	ANGE1	Y	100	11.00	13.72	100	16.40	21.64	100	17.20	21.99
POACEAE	Andropogon scoparius Michx.	ANSC1	Y	100	2.60	3.24	20	0.40	0.53	80	2.40	3.07
POACEAE	Aristida purpurea Nutt. var. robusta (Merrill) A. Holmgren & N. Holmgr	ARLO1	Y				20	0.20	0.26	60	0.60	0.77
POACEAE	Bouteloua curtipendula (Michx.) Torr.	BOCU1	Y	40	0.40	0.50	80	1.20	1.58	20	0.40	0.51
POACEAE	Bouteloua gracilis (H. B. K.) Lag ex Griffiths	BOGR1	Y	100	1.20	1.50	40	0.40	0.53			
POACEAE	Bouteloua hirsuta Lag	BOHI1	Y	60	1.40	1.75	20	0.20	0.26	60	0.60	0.77
POACEAE	Bromus japonicus Thunb. ex Murr.	BRJA1	N	20	1.00	1.25	60	1.20	1.58	60	3.80	4.86
POACEAE	Bromus tectorum L.	BRTE1	N	20	0.20	0.25	40	0.60	0.79	20	0.20	0.26
POACEAE	Koeleria pyramidata (Lam.) Beauv.	KOPY1	Y	80	1.80	2.24	40	0.40	0.53	100	1.00	1.28
POACEAE	Muhlenbergia montana (Nutt.) Hitchc.	MUMO1	Y	100	26.60	33.17	100	20.00	26.39	100	18.60	23.79
POACEAE	Poa compressa L.	POCO1	N	80	7.00	8.73	100	18.60	24.54	100	6.40	8.18
POACEAE	Poa pratensis L.	POPR1	N	60	3.00	3.74	80	3.00	3.96	80	5.20	6.65
POACEAE	Sitanion hystrix (Nutt.) Sm. var. brevifolium (Sm.) Hitchc.	SIHY1	Y	80	1.00	1.25	20	0.20	0.26	40	0.40	0.51
POACEAE	Sorghastrum nutans (L.) Nash	SONU1	Y	80	0.80	1.00	60	1.00	1.32	20	0.60	0.77
POACEAE	Sporobolus cryptandrus (Torr.) A. Gray	SPCR1	Y							20	0.20	0.26
POACEAE	Sporobolus heterolepis (A. Gray) A. Gray	SPHE1	Y				20	0.40	0.53			
POACEAE	Stipa comata Trin. & Rupr.	STCO1	Y	80	2.60	3.24	40	0.40	0.53	60	4.20	5.37

TABLE 4-4. (cont.)

Family	Scientific Name	Speccode	Native	BC1 - Control			BT1 - Treatment 1			BT2 - Treatment 2		
				Mean			Mean			Mean		
				% F	% F	% F	% F	R C	% F	R C	% F	R C
				F	A	R	F	A	I	F	A	I
				r	b	i	r	b	i	r	b	i
				e	s	a	e	s	a	e	s	a
				q	o	r	q	o	r	q	o	r
				u	l	t	u	l	t	u	l	t
				e	u	C	e	u	C	e	u	C
				n	t	o	n	t	o	n	t	o
				c	e	v	c	e	v	c	e	v
				y	e	r	y	e	r	y	e	r
POLYGONACEAE	Eriogonum alatum Torr.	ERAL1	Y	40	0.40	0.50						
SCROPHULARIACEAE	Linaria dalmatica (L.) Mill.	LIDA1	N	40	0.40	0.50				20	0.40	0.51
Total Foliar Cover (%)				80.20	100.00		75.80	100.00		78.20	100.00	
Total Relative Native Foliar Cover (%)						82.54			68.07			75.45

Frequency = the percentage of the total number of transects that a given species was encountered on (n=5).

Absolute Cover = the mean number of hits of a given species expressed as a percentage of the total number of hits possible (n=5)  
(total number of hits of a species/total # hits possible [500]).

Relative Cover = the mean percent cover of a given species expressed as a percentage of the total vegetative cover of all species encountered (n = 5) (total number of hits of a species/total # hits of all species).

**TABLE 4-5. 1997 BASAL COVER DATA SUMMARY FOR  
XERIC TALLGRASS PRAIRIE PLOTS**

Plot	Vegetation %	Litter %	Rock %	Bare Ground %
BC1 - Control	11.6	74.8	9.4	4.2
BT1 - Treatment 1	13	75	10.6	1.4
BT2 - Treatment 2	12	72.8	10.8	4.4

Values are mean percent cover.

TABLE 4-6. 1997 QUADRAT FREQUENCY DATA SUMMARY FOR XERIC TALLGRASS PRAIRIE PLOTS

Scientific Name	Speccode	BC1- Control			BT1 - Treatment 1			BT2 - Treatment 2		
		S % p r F i r n e g q u e n c y	S % u m F m r e e r q u e n c y	D i f f r e e n c e	S % p r F i r n e g q u e n c y	S % u m F m r e e r q u e n c y	D i f f r e e n c e	S % p r F i r n e g q u e n c y	S % u m F m r e e r q u e n c y	D i f f r e e n c e
Achillea millefolium L. ssp. lanulosa (Nutt.) Piper	ACMI1	8	12	4						
Agropyron smithii Rydb.	AGSM1				4	4	0	0	4	4
Alyssum alyssoides (L.) L.	ALAL1							0	4	4
Alyssum minus (L.) Rothmaler var. micranthus (C. A. Mey.) Dudley	ALMI1				8	12	4	64	72	8
Allium textile A. Nels. & Macbr.	ALTE1	12	8	-4	12	0	-12	20	4	-16
Ambrosia psilostachya DC.	AMPS1	44	40	-4	52	60	8	40	56	16
Andropogon gerardii Vitman	ANGE1	64	52	-12	76	80	4	64	72	8
Antennaria parvifolia Nutt.	ANPA1	8	4	-4						
Andropogon scoparius Michx.	ANSC1	60	60	0	20	28	8	32	44	12
Artemisia campestris L. ssp. caudata (Michx.) Hall & Clem.	ARCA1	20	20	0	16	24	8	28	24	-4
Arenaria fendleri A. Gray	ARFE2	80	84	4	40	48	8	32	72	40
Artemisia frigida Willd.	ARFR1	16	20	4	12	12	0	32	32	0
Arnica fulgens Pursh.	ARFU1				4	0	-4			
Arabis hirsuta (L.) Scop. var. pynocarpa (Hopkins) Rollins	ARHI1	56	44	-12	36	24	-12	52	44	-8
Aristida purpurea Nutt. var. robusta (Merrill) A. Holmgren & N. Holmgr	ARLO1	0	4	4	4	16	12	4	8	4
Artemisia ludoviciana Nutt. var. ludoviciana	ARLU1	8	8	0	20	24	4	24	20	-4
Astragalus agrestis Dougl. ex G. Don	ASAG1	8	8	0	4	4	0			
Aster porteri Gray	ASPO1	84	84	0	48	56	8	68	76	8
Asclepias stenophylla A. Gray	ASST1							0	4	4
Bouteloua curtipendula (Michx.) Torr.	BOCU1	48	56	8	12	28	16	8	32	24
Bouteloua gracilis (H. B. K.) Lag ex Griffiths	BOGR1	44	52	8	28	44	16	20	40	20
Bouteloua hirsuta Lag	BOHI1	12	36	24	8	12	4	4	24	20
Bromus japonicus Thunb. ex Murr.	BRJA1				4	16	12	16	40	24
Bromus tectorum L.	BRTE1	0	4	4				0	4	4
Carex eleocharis Bailey	CAEL1				4	0	-4			
Carex heliophila Mack.	CAHE1	88	88	0	72	88	16	76	92	16
Carduus nutans L. ssp. macrolepis (Peters.) Kazmi	CANU1							8	12	4
Castilleja sessiliflora Pursh.	CASE3							4	0	-4
Centaurea diffusa Lam.	CEDI1	16	28	12	40	48	8	32	52	20
Chrysopsis fulcrata Greene	CHFU1	44	44	0	12	12	0			
Chrysopsis villosa Pursh.	CHVI1	32	20	-12				0	4	4
Cirsium undulatum (Nutt.) Spreng.	CIUN1				4	4	0	12	8	-4
Dalea purpurea Vent	DAPU1	4	4	0	0	4	4	4	8	4
Draba reptans (Lam.) Fern.	DRRE1	12	4	-8	12	8	-4	20	4	-16
Echinocereus viridiflorus Engelm.	ECVI1	32	40	8	32	36	4	56	56	0
Eriogonum alatum Torr.	ERAL1	64	68	4	36	40	4	24	24	0
Erysimum capitatum (Nutt.) DC.	ERCA2				44	28	-16	40	44	4
Erigeron divergens T. & G.	ERDI1	8	0	-8	24	0	-24	32	0	-32
Erigeron flagellaris A. Gray	ERFL1	4	20	16	4	24	20	8	28	20
Euphorbia robusta (Engelm.) Small	EURO1							4	0	-4
Gaillardia aristata Pursh.	GAAR1	12	12	0	16	0	-16	20	20	0
Gaura coccinea Pursh.	GACO1				4	0	-4			

TABLE 4-6. (cont.)

Scientific Name	Speccode	BC1- Control			BT1 - Treatment 1			BT2 - Treatment 2		
		S % p r i n g u e n c y	S % u m r e e n c y	D i f f e r e n c e	S % p r i n g u e n c y	S % u m r e e n c y	D i f f e r e n c e	S % p r i n g u e n c y	S % u m r e e n c y	D i f f e r e n c e
Grindelia squarrosa (Pursh.) Dun.	GRSQ1	4	4	0	8	4	-4	32	48	16
Gutierrezia sarothrae (Pursh.) Britt. & Rusby	GUSA1							4	4	0
Hedeoma hispidum Pursh.	HEHI1				0	4	4			
Hypericum perforatum L.	HYPE1	56	60	4	56	64	8	60	84	24
Juncus dudleyi Wieg.	JUDU1				4	0	-4			
Juncus interior Wieg.	JUIN1	0	12	12	0	16	16			
Koeleria pyramidata (Lam.) Beauv.	KOPY1	72	72	0	16	32	16	40	52	12
Lactuca serriola L.	LASE1	8	12	-4	12	24	12	12	12	0
Lesquerella montana (A. Gray) Wats.	LEMO1	76	64	-12	72	60	-12	76	72	-4
Leucocrinum montanum Nutt.	LEMO2	8	0	-8						
Linaria dalmatica (L.) Mill.	LIDA1	28	28	0				16	16	0
Lithospermum incisum Lehm.	LIIN1							0	12	12
Liatris punctata Hook.	LIPU1	80	80	0	52	52	0	44	44	0
Lomatium orientale Coult. & Rose	LOOR1	100	4	-96	96	4	-92	92	0	-92
Mertensia lanceolata (Pursh.) A. DC.	MELA1							8	0	-8
Mirabilis linearis (Pursh.) Heimerl	MILI1				0	4	4			
Muhlenbergia montana (Nutt.) Hitchc.	MUMO1	76	84	8	76	80	4	64	68	4
Opuntia macrorhiza Engelm.	OPMA1	28	32	-4	56	64	8	52	52	0
Orobanche fasciculata Nutt.	ORFA1	4	0	-4	4	0	-4			
Oxytropis lambertii Pursh.	OXLA1							12	4	-8
Paronychia jamesii T. & G.	PAJA1	12	16	4	16	16	0	0	8	8
Penstemon virens Penn.	PEVI1	20	8	-12	8	4	-4	4	8	4
Phacelia heterophylla Pursh.	PHHE1							4	4	0
Poa compressa L.	POCO1	64	60	-4	96	92	-4	64	72	8
Poa pratensis L.	POPR1	32	36	4	28	20	-8	44	40	-4
Polygonum sawatchense Small	POSA1	0	4	4						
Psoralea tenuiflora Pursh.	PSTE1	20	36	16	0	28	28	8	20	12
Senecio plattensis Nutt.	SEPL1	28	12	-16				16	8	-8
Sisymbrium altissimum L.	SIAL1				4	0	-4			
Silene antirrhina L.	SIAN1	16	12	-4	12	12	0	4	4	0
Sitanion hystrix (Nutt.) Sm. var. brevifolium (Sm.) Hitchc.	SIHY1	8	32	24	0	12	12	4	16	12
Solidago mollis Bart.	SOMO1	12	8	-4	12	12	0	4	8	4
Sorghastrum nutans (L.) Nash	SONU1	0	28	28						
Sphaeralcea coccinea (Pursh.) Rydb.	SPCO1							4	0	-4
Stipa comata Trin. & Rupr.	STCO1	32	40	8	8	24	16	52	60	8
Taraxacum officinale Weber	TAOF1							0	4	4
Tragopogon dubius Scop.	TRDU1	36	36	0	16	16	0	28	60	32
Tradescantia occidentalis (Britt.) Smyth	TROC1				4	0	-4			
Viola nuttallii Pursh.	VINU1	4	0	-4	8	0	-8	16	0	-16

Frequency = the percentage of the total number of quadrats that a given species was encountered on (n=25)

Difference = the difference in frequency values between the spring and summer sampling periods (n=25)

TABLE 4-7. 1997 XERIC TALLGRASS PRAIRIE PLOT WEED DENSITIES

Sample Site	Scientific Name	Speccode	Mean Spring Density (# plants/m <sup>2</sup> )
BC1-Control	<i>Centaurea diffusa</i> Lam.	CEDI1	0.24
BC1-Control	<i>Grindelia squarrosa</i> (Pursh.) Dun.	GRSQ1	0.04
BC1-Control	<i>Hypericum perforatum</i> L.	HYPE1	1.28
BC1-Control	<i>Linaria dalmatica</i> (L.) Mill.	LIDA1	3.12
BT1-Treatment 1	<i>Centaurea diffusa</i> Lam.	CEDI1	1.12
BT1-Treatment 1	<i>Grindelia squarrosa</i> (Pursh.) Dun.	GRSQ1	0.08
BT1-Treatment 1	<i>Hypericum perforatum</i> L.	HYPE1	1.4
BT2-Treatment 2	<i>Carduus nutans</i> L. ssp. <i>macrolepis</i> (Peterm.) Kazmi	CANU1	0.12
BT2-Treatment 2	<i>Centaurea diffusa</i> Lam.	CEDI1	0.88
BT2-Treatment 2	<i>Grindelia squarrosa</i> (Pursh.) Dun.	GRSQ1	0.56
BT2-Treatment 2	<i>Hypericum perforatum</i> L.	HYPE1	2.48
BT2-Treatment 2	<i>Linaria dalmatica</i> (L.) Mill.	LIDA1	2.04

**TABLE 4-8. 1997 XERIC TALLGRASS PRAIRIE PLOT CACTUS DENSITIES**

Sample Site	Scientific Name	Speccode	Mean Spring Density (# plants/m <sup>2</sup> )
BC1-Control	Echinocereus viridiflorus Engelm.	ECVI1	24.8
BC1-Control	Opuntia macrorhiza Engelm.	OPMA1	32.4
BT1-Treatment 1	Coryphantha missouriensis (Sweet) Britt. & Rose	COMI1	0.2
BT1-Treatment 1	Echinocereus viridiflorus Engelm.	ECVI1	33.2
BT1-Treatment 1	Opuntia macrorhiza Engelm.	OPMA1	61.8
BT2-Treatment 2	Echinocereus viridiflorus Engelm.	ECVI1	42.2
BT2-Treatment 2	Opuntia macrorhiza Engelm.	OPMA1	52.4

## Section 5

## **5. 1997 HIGH-VALUE PLANT COMMUNITY SURVEY SUMMARY FOR ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE**

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This section presents the results of the revised vegetation monitoring plan that was initiated in 1997.

### **5.1 BACKGROUND**

The vegetation monitoring program was re-evaluated in the fall of 1996, to assess the type of vegetation information needed to make ecological resource management decisions at the Rocky Flats Environmental Technology Site (Site). Previous studies at the Site had provided quantitative baseline ecological information for some of the vegetation communities (K-H 1997a; DOE 1992, 1995), but other types of information, at a larger scale, were needed to supplement these data for making practical land management decisions. The goal developed for the vegetation monitoring program was to conduct additional annual monitoring that would qualitatively assess the status of the high-value plant communities (xeric tallgrass prairie, tall upland shrubland, selected wetlands, and Great Plains riparian woodland), evaluate the quality of the communities, and document any changes (K-H 1997b). The high-value vegetation communities were selected for evaluation on the basis of recommendations from Site ecologists and the Colorado Natural Heritage Program (CNHP 1994, 1995). Questions were posed that could be used to evaluate the communities at a larger scale with respect to species richness, as well as rare plants, disturbance, weed problems, erosion, habitat quality, changes in the communities, and other factors. These questions were then used to define information needs and methodology. The list of questions is not repeated here, but can be found in the *High-Value Vegetation Survey Plan for the Rocky Flats Environmental Technology Site* (K-H 1997b).

### **5.2 METHODS**

The revised vegetation monitoring plan included the following qualitative components for each of the high-value plant communities (K-H 1997b):

- Species richness inventories
- Mapping of noxious weeds, Threatened and Endangered (T&E) species, Species of Special Concern, and Site rare species
- Photographic documentation
- Qualitative habitat assessments.

Each of the high-value plant communities was divided into several management units (see maps in Appendix A in K-H 1997b). Management units were defined on the basis of existing drainages, roads, or fencelines, to break each community into smaller areas that could be assessed readily. Species richness inventories of each of the high-value plant communities were conducted in 1997 by traversing each management unit twice during the growing season (spring and late summer) and recording all vascular plant species observed. The purpose of the inventories was to provide a floristic checklist for each of the high-value plant communities. Routes traversed in the spring were drawn on maps and used again for the late-summer sampling. Attempts were also made to visit, as completely as possible, all areas and microhabitats occurring within the management units.

During 1997, a mapping project was initiated, in conjunction with the high-value vegetation survey, to document known Site locations of the Colorado Natural Heritage Program (CNHP) Species of Concern. The CNHP tracks Colorado's plants, animals, and natural communities at both a global and state level, and assigns each species or community a ranking that indicates the degree of imperilment each faces with regard to extirpation or extinction. Four species of plants known to occur on Site are listed as Species of Concern for Colorado (CNHP 1997): the mountain-loving sedge (*Carex oreocharis*), forktip three-awn (*Aristida basiramea*), dwarf wild indigo (*Amorpha nana*), and carrionflower greenbriar (*Smilax herbacea* var. *lasioneuron*). Prior to 1997, only the location of the forktip three-awn population had been mapped at the Site.

Several species of weeds are known to occur in the Buffer Zone, some of which are highly aggressive and are contributing to the degradation and loss of native species richness and composition in the plant communities on Site. As a means of identifying high-priority areas for weed control, monitoring the distribution of the weeds on Site, and providing a way of tracking the effectiveness of weed control, a mapping initiative was begun in 1997 to annually map the distribution of certain high-priority weed species. Weed mapping was conducted on foot in the high-value vegetation communities and from a vehicle across the remainder of the Site. The species mapped included diffuse knapweed (*Centaurea diffusa*), musk thistle (*Carduus nutans*), dalmatian toadflax (*Linaria dalmatica*), and mullein (*Verbascum thapsus*). Canada thistle (*Cirsium arvense*) was not mapped, because it was common throughout most of the wetlands on Site, and therefore, the wetlands map provides a good indication of the infested areas.

Infested areas were classified into general categories of high, medium, low, and scattered density levels, based on a subjective interpretation of the extent, visual density, need for control, and aggressive nature of the species. In general, a high-density classification indicated that an area was dominated by a nearly solid infestation and/or very high cover of the species. A medium-density category was used where the infestation provided less cover and was less solid, perhaps with breaks in the distribution of the species. The low-density category was used where the species was present but in fewer numbers and was not visually dominating the landscape, but where it was beginning to establish a foothold in the community and should be controlled. The scattered-density category was only used in a few cases and indicated a sporadic occurrence of the species. The boundaries shown

on the maps are only approximate and are based on professional judgement. They should not be interpreted as precisely outlining the distribution of these species, because no surveying or GPS equipment was used to locate boundary edges, nor do the maps necessarily represent every location of the species on Site.

The rare plant and noxious weed populations and distributions were drawn in the field on 11- by 17-in. maps of each management unit. These were then transferred to a 44- by 34-in. blank sitewide map and subsequently entered into the GIS as separate coverages for each weed species, and as a single coverage for the rare plant species.

Photographic documentation was conducted in each management unit by placing permanently marked points at selected locations and photographing the management units in different directions from those points. Locations of the permanently marked points were drawn on field maps and later entered into the Site GIS. In addition, at the grassland photo points, a 1-m<sup>2</sup> quadrat was placed on the ground and photographed, using the permanent marker as a reference point. Habitat location codes, photo numbers, and the compass directions for each of the photos taken were recorded to assist with future photography from the same locations.

Qualitative habitat assessments were made in each management unit using a habitat assessment form, which was developed from forms and questions used by other agencies (see list in K-H 1997a). The questions dealt primarily with habitat loss, threats to the plant community, noxious weed distributions and density estimates, rare plant species, dominant plant species health in the community, and general community quality. Further details on each of the methodologies may be found in the *High-Value Vegetation Survey Plan for the Rocky Flats Environmental Technology Site* (K-H 1997a) and the *Environmental Management Department Operating Procedures Manual* (DOE 1995a).

Quantitative monitoring was also conducted in 1997, to evaluate the effects of weed control applications and a planned controlled burn on the xeric tallgrass prairie at the Site. The results of these studies were presented in previous sections of this report.

## **5.3 RESULTS**

### **5.3.1 Species Richness**

The 1997 species richness inventory results for the high-value plant communities are found in Table 5-1. A total of 469 species of vascular plants were recorded from all communities combined, and Table 5-2 lists the species recorded from each community. The community with the highest plant species richness on Site was the tall upland shrubland (352 species), followed by the Great Plains riparian woodland (336 species), xeric tallgrass prairie (274 species), and wetlands (260 species; Table 5-1). The percentage of native species in the different communities ranged between 77 and 82 percent (Table 5-1). A Sorenson coefficient of similarity index (Brower and Zar 1977) was calculated for each

of the combinations of communities, and results are presented in Table 5-3. The lowest species richness similarity occurred between the xeric tallgrass prairie and the wetland community (0.56; Table 5-3). The highest similarity occurred between the tall upland shrubland and Great Plains riparian woodland (0.78; Table 5-3). All comparisons between the xeric tallgrass prairie and other communities had lower similarity indices than did comparisons between the wetland, shrubland, or woodland communities.

As a result of the floristic inventories conducted in the high-value plant communities during 1997, 26 new records of vascular plant species were reported for the Site. Additionally, one previously misidentified species was identified correctly, and two subspecies of *Chrysothamnus* (rabbitbrush) were identified from the previous single species thought to occur on Site. Plant nomenclature follows that of GPFA (1986), Weber (1976), and Weber (1990), in that order of determination. The new plant species reported for the Site included:

*Alopecurus geniculatus* L.  
*Amorpha nana* Nutt. - a Colorado Natural Heritage Program Species of Concern  
*Apera interrupta* (L.) Beauvois  
*Calystegia macouni* (Greene) Brummitt  
*Chenopodium overi* Aellen  
*Clematis hirsutissima* Pursh  
*Conosilene conica* (L.) Fourreau ssp. *conoidea* (L.) Love & Kjellqvist  
*Cryptantha virgata* (Porter) Payson  
*Elymus juncea* Fisch.  
*Eragrostis pilosa* (L.) Beauv.  
*Erigeron vetensis* Rydb.  
*Eriogonum effusum* Nutt.  
*Euphorbia fendleri* T.&G.  
*Gnaphalium chilense* Spreng.  
*Hackelia floribunda* (Lehm.) I. M. Johnst.  
*Hypericum majus* (A. Gray) Britt.  
*Machaeranthera canescens* (Pursh) A. Gray  
*Myriophyllum exalbescens* Fern.  
*Penstemon strictus* Benth in De Candolle  
*Poa bulbosa* L.  
*Potamogeton foliosus* Raf.  
*Potentilla norvegica* L.  
*Potentilla paradoxa* Nutt.  
*Ranunculus scleratus* L.  
*Rumex salicifolius* Weinm. ssp. *triangulivalvis* Danser (replaced the previously misidentified *Rumex mexicanus* Meisn. on the species list).  
*Salix fragilis* L.  
*Salix lutea* Nutt.

The species *Chrysothamnus nauseosus* (Pall.) Britt. has been split into two subspecies to represent the two forms that occur on Site:

*Chrysothamnus nauseosus* (Pall.) Britt. ssp. *graveolens* (Nutt.) Piper  
(This is the taller, more robust species that grows in large clumps.)

*Chrysothamnus nauseosus* (Pall.) Britt. ssp. *nauseosus*  
(This is the shorter-stature species.)

### 5.3.2 Rare Species Mapping

The rare-plant mapping initiative conducted in 1997 documented several locations where the four CNHP Species of Concern are known on the Site. Figure 5-1 shows the currently known locations for populations of the mountain-loving sedge, forktip three-awn, dwarf wild indigo, and carrionflower greenbriar.

Populations of the mountain-loving sedge were most common in the Rock Creek drainage, along the northern edges of the pediments in the xeric tallgrass prairie (Figure 5-1). Population estimates ranged from less than 50 to more than 1,000 clumps of the species at the different locations. A single clump of dwarf wild indigo, consisting of eight stems, was found near the top of a side drainage in Rock Creek (Figure 5-1). The previously known location for forktip three-awn was relocated along the railroad tracks west of the Industrial Area (Figure 5-1), where more than 1,000 plants were estimated to occur. Several locations of carrionflower greenbriar were noted in the tall upland shrubland across the Site, with all but one occurring in the Rock Creek drainage (Figure 5-1). Population estimates for the carrionflower greenbriar ranged from 1 to 50 individuals per location.

### 5.3.3 Weed Species Mapping

The 1997 weed distribution maps for diffuse knapweed, musk thistle, dalmatian toadflax, and mullein are shown in Figures 5-2, 5-3, 5-4, and 5-5, respectively. As a means of determining the overall distribution of these species on Site, the estimated total acreage infested by each species, and the infestation level, were calculated from the GIS coverages. Table 5-4 contains the estimated total acreage and acreage by density category for each of the species, based on these maps. The species with the greatest extent was diffuse knapweed, covering nearly 2,678 acres, followed by mullein (575 acres), musk thistle (474 acres), and dalmatian toadflax (422 acres). The total acreage of the Site is approximately 6,485 acres (K-H 1997a). (These acreages are approximate.)

In addition to the weed distribution maps, a map was prepared showing the extent of weed control efforts in the Buffer Zone from FY1997 through December of FY1998 (Figure 5-6). This map shows both chemical and biological controls used on various weed species during this time frame. Table 5-5 shows the approximate acreages treated with Tordon 22K and Transline during this time frame, with most of it being directed at diffuse

knapweed. In FY1997, approximately 275 acres of grassland were treated with Tordon 22K, and an additional 16 acres in the upper reaches of Rock Creek were treated with Transline (Table 5-5). So far in FY1998, approximately 245 acres of grassland have been treated with Tordon 22K (Table 5-5). Both the FY1997 and FY1998 applications were made either by truck-mounted or backpack sprayers. Over the past two years, approximately 536 acres of diffuse knapweed-infested areas have been treated. In addition, during FY1997, two biological control agents were released on Site by the Colorado Department of Agriculture. In July, *Sphenoptera jugoslavica*, a root-boring beetle that feeds on diffuse knapweed, was released in the far north Buffer Zone, to provide partial control of the diffuse knapweed at that location (Figure 5-6). In August, *Calophasia lunula* larvae (caterpillars), which feed on dalmatian toadflax foliage, were released on the pediment east of the Industrial Area in an attempt to reduce the amount of dalmatian toadflax in this area and control its spreading (Figure 5-6).

#### **5.3.4 Photographic Documentation and Qualitative Habitat Assessment Forms**

A total of 45 permanently marked photo locations were set up across the Site in 1997 to document visible change in the high-value vegetation communities (Figure 5-7), and 148 photographs were taken at these locations. A database was created that contains information concerning the photos, including the date, the photo location point identification number, the high-value communities photographed, the compass direction from which the photos were taken, the focal length of the lens used, and the photo identification numbers for obtaining reprints. For easier use by ecology staff, the photo location points on the map and the database were linked using ArcView GIS software, so that by clicking on a photo location on the computer screen, one can get a list of the photos taken from each point. Some examples of the photos taken in the different plant communities during 1997 are shown in Figures 5-8 through 5-13.

A total of 44 qualitative habitat assessment forms were completed, one for each management unit, in 1997. No analysis was done on any of the data from these forms, because of the qualitative nature of the information; however, the information from these assessments is presented and discussed in the following section.

### **5.4 DISCUSSION**

The high-value vegetation species richness inventory results from 1997 parallel those from the same plant communities sampled by the Ecological Monitoring Program (EcMP) from 1993 through 1995 (K-H 1997a; DOE 1995b). The dryer xeric plant communities had lower species richness than the wetter communities. Comparison of the high-value vegetation species lists for the xeric tallgrass prairie and riparian community against the species lists generated during the EcMP sampling in the xeric mixed grassland and riparian woodland complex revealed a large difference in the total number of species detected. However, these species lists were generated using two different methodologies, and the EcMP studies used only data from 15-100-m<sup>2</sup> transects in each community type. The

species lists in 1997 were generated by hiking throughout the entire plant community and recording the species observed. During 1995, maximum species richnesses of 134 and 196 species were recorded at EcMP transects in the xeric mixed grassland and riparian woodland complex communities, respectively (K-H 1997a). In 1997, species richnesses of 274 and 336 species were recorded in the xeric tallgrass prairie and riparian woodland communities, respectively (Table 5-1). No comparisons were possible for wetland and tall upland shrubland communities, because the EcMP did not collect data in them.

Although the EcMP study was not designed to provide a complete species list for each community sampled, the comparison here provides some insights into the percentage of species in the communities detected by sampling 1500 m<sup>2</sup>. In the xeric tallgrass prairie, the EcMP sampling detected only 48 percent of the species found by a community-wide inventory (K-H 1997a). In the riparian woodland complex, the EcMP sampling detected 58 percent of the species (K-H 1997a). Therefore, the species lists generated from the 1997 sampling (Table 5-2) provide a much more complete inventory of the species found in the four high-value vegetation communities, and they will be valuable in assessing any future changes in these communities.

The mapping initiatives begun in 1997 for rare plants and weed species distributions provided important information for land management and project planning, supporting DOE's desire to protect the Site's ecological resources. The rare plants map showing the known population locations of the mountain-loving sedge, forktip three-awn, dwarf wild indigo, and carrionflower greenbriar (Figure 5-1) provides important information needed to protect these species. In addition, the 1997 mapping effort also documented the distribution of common hops (*Humulus lupulus* var. *lupuloides*) on Site. Although not shown, this information (now in the Site GIS) provides important habitat distribution information for a rare butterfly that was identified by the CNHP as occurring on Site. The hops blue butterfly (*Celestrina* sp.) relies on common hops as a host plant for part of its life. The information gathered in 1997 and put into the Site GIS can now be used in conjunction with information on other sensitive ecological resources at the Site and will assist in making land management and project planning decisions that help avoid impacts to these species.

The maps of the 1997 weed species distributions on Site (Figures 5-2 through 5-5) will be (and have already been) used to help focus weed control efforts. In addition, these maps will be used in conjunction with the map showing where weed control has been applied (Figure 5-6) to allow Site ecologists to determine the effectiveness of weed control efforts as annual weed distribution mapping continues in future years. It will be possible to overlay the areas where weed control was applied in a previous year on top of weed distributions for the current year to graphically depict the changes that have taken place as a result of weed control. The effectiveness of the weed control done in 1997 can be assessed by comparing the 1997 and 1998 weed distribution maps to the map of areas sprayed in 1997. This will also provide a method of determining how long the effectiveness of a weed control effort will last before reapplication is necessary, because the annual

weed mapping will illustrate graphically how long it takes for a treated area to return to the pretreatment density level.

Other ongoing monitoring (presented elsewhere in this report) is examining the effect of herbicide treatments on the Site's native grasslands. These two combined monitoring techniques provide important information on the effectiveness of weed control efforts and how the quality and health of the plant communities on Site are affected by the weed control treatments.

Qualitative habitat assessments made in each management unit of the high-value vegetation communities, and also in the mesic mixed grassland, during 1997 provided information on various concerns for each community. There was no documented man-made loss in the areal extent for any of the communities evaluated in 1997. In some management units, there were signs of human disturbance in the community, in the form of trash and vehicle tracks off the roads. In general, trash was seen most often along the riparian woodland corridors and in the tall upland shrubland management units (in the upper ends of the Rock Creek drainage), where it was often caught up in the woody vegetation. In the xeric tallgrass prairie, trash was most prevalent in the northern and northwestern management units on Site, probably because this material is blown onto DOE property from Highway 93, the mining operations, and the renewable energy wind site. Off-road vehicle tracks were found primarily in the grassland communities, mostly resulting from vehicles traveling to old well locations for sampling.

The greatest natural threat identified in each community, most significantly in the grassland communities, was from weeds. The species of greatest concern was diffuse knapweed, which as shown on the weed maps, has invaded nearly 2,678 acres on the Site (Figure 5-2; Table 5-4). Depending on the location, however, other species—such as dalmatian toadflax, Russian thistle (*Salsola iberica*), mullein, musk thistle, curly-top gumweed (*Grindelia squarrosa*), and Canada thistle—also posed problems in the different communities (Figures 5-3 through 5-5; Table 5-4). Management action with respect to continued and increased levels of weed control continues to be a major need in the plant communities on Site. However, weed control is only one facet of needed ecosystem management for the Site, as discussed below.

A qualitative assessment of the overall health and quality of the plant communities on Site suggests that, although many of the dominant native species generally appeared healthy, there are indications that the communities may be stressed. No obvious signs of disease, predation, injury, or death were noted for most species. On many of the chokecherry (*Prunus virginiana*) plants and on some of the American plum (*Prunus americana*), there was evidence of tent caterpillars (*Malacosoma* sp.) and some leaf gall problems, but there did not appear to be any significant detrimental effect. Of those species examined (see K-H 1997b for a listing), at least a portion of the population flowered in 1997, and many showed evidence of some vegetative reproduction. In the grassland communities, the high amounts of plant litter at many locations in the grasslands, from a lack of fire and grazing, indicate that nutrients are tied up in the dead biomass, slowing the nutrient cycling in the

ecosystem. However, few of the native species were observed to have flowered prolifically during 1997, with the exception of mountain muhly (*Muhlenbergia montana*), which seemed to have had a good year. Many of the native bunch grasses are buried in their own dead plant litter, produce less plant material, and flower less. On the xeric tallgrass prairie, the little bluestem (*Andropogon scoparius*) showed some evidence of stress, and some plants were dying or dead. Some of this may have been the result of the drought that hit the species hard in the summer of 1994 and still affects it. However, another likely reason for much of the lack of vigor in little bluestem, and for many other native species, as well as for the degraded, weedy condition of the grassland community, is the accumulation of dead plant litter and resultant low nutrient cycling. Much of this problem can be traced to the lack of grazing and suppression of fire at the Site for more than 40 years at some locations.

Historically, prior to DOE purchase, the grasslands at the Site were heavily overgrazed (Clark 1980; Weber 1974)). After DOE purchased the lands, grazing was no longer allowed, wildfires were suppressed, and the land was essentially left alone. For many years under this type of management, the plant communities probably recovered to some extent from the past overgrazing practices. In recent years, however, many of these gains have begun to reverse. Without grazing or fire to recycle nutrients and stimulate the growth and vigor of the native species, weeds have become established and have taken over many areas. Studies have shown that the lack of fire and grazing in prairie communities can alter the species composition and allow the invasion of exotic species (Howe 1994; Wedin 1992; Ewing and Engle 1988; Collins 1987).

The current use of herbicide treatments at the Site to control weed species such as diffuse knapweed, dalmatian toadflax, and potentially other exotic graminoid species, while certainly needed, is not a long-term solution to the problem. Only a combination of weed control and other management techniques will be successful in the long term. Areas degraded because of weeds or disturbance need to be reseeded with native species to enhance the chances for long-term sustainability of the native plant communities on Site. There must also be a commitment to restoring the natural processes and functions that are necessary to maintain a healthy, vigorous native ecosystem that can resist invasion by exotic species. A multi-faceted approach, which has been suggested previously for managing the ecological resources at the Site (K-H 1997a,c,d), would involve the use of controlled burns, limited and controlled grazing, revegetation and restoration of degraded areas, weed control, and habitat enhancement. From both an economic and ecological standpoint, the use of weed control alone as a management tool is an expensive temporary bandage on a much larger problem. Management practices must begin to address the ecological problems on Site in terms of the ecological processes and functions that are necessary to maintain a healthy ecosystem. Without such an approach, it is likely that the quality of the plant communities and wildlife habitat on Site will continue to degrade.

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







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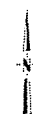
**Rare and Imperiled Plants Distribution  
Colorado Natural Heritage Program  
Species of Concern  
Figure S-1**

**MAP LEGEND**

**Standard Map Features**

-  Carionflower Greenbrier (*Smilax herbacea*)
-  Forklip Three-Aw (Asteraceae)
-  Mountain-loving Sedge (*Carex oreochloa*)
-  Dwarf Wild Indigo (*Amorpha nana*)
-  Buildings and other structures
-  Solar evaporation ponds
-  Lakes and ponds
-  Streams, ditches, or other drainage features
-  Fences and other barriers
-  Contour (20-Foot)
-  Paved roads
-  Dirt roads

DATA SOURCE:  
1987 rare and imperiled plant distribution  
at Rocky Flats Environmental Technology Site  
by the Colorado Natural Heritage Program  
of the Colorado Department of Natural Resources  
and the U.S. Department of Energy  
and is derived from a series of maps. These  
maps were prepared by the Colorado Natural  
Heritage Program, Colorado State University.



Scale = 1 : 21330  
1 inch represents approximately 1778 feet

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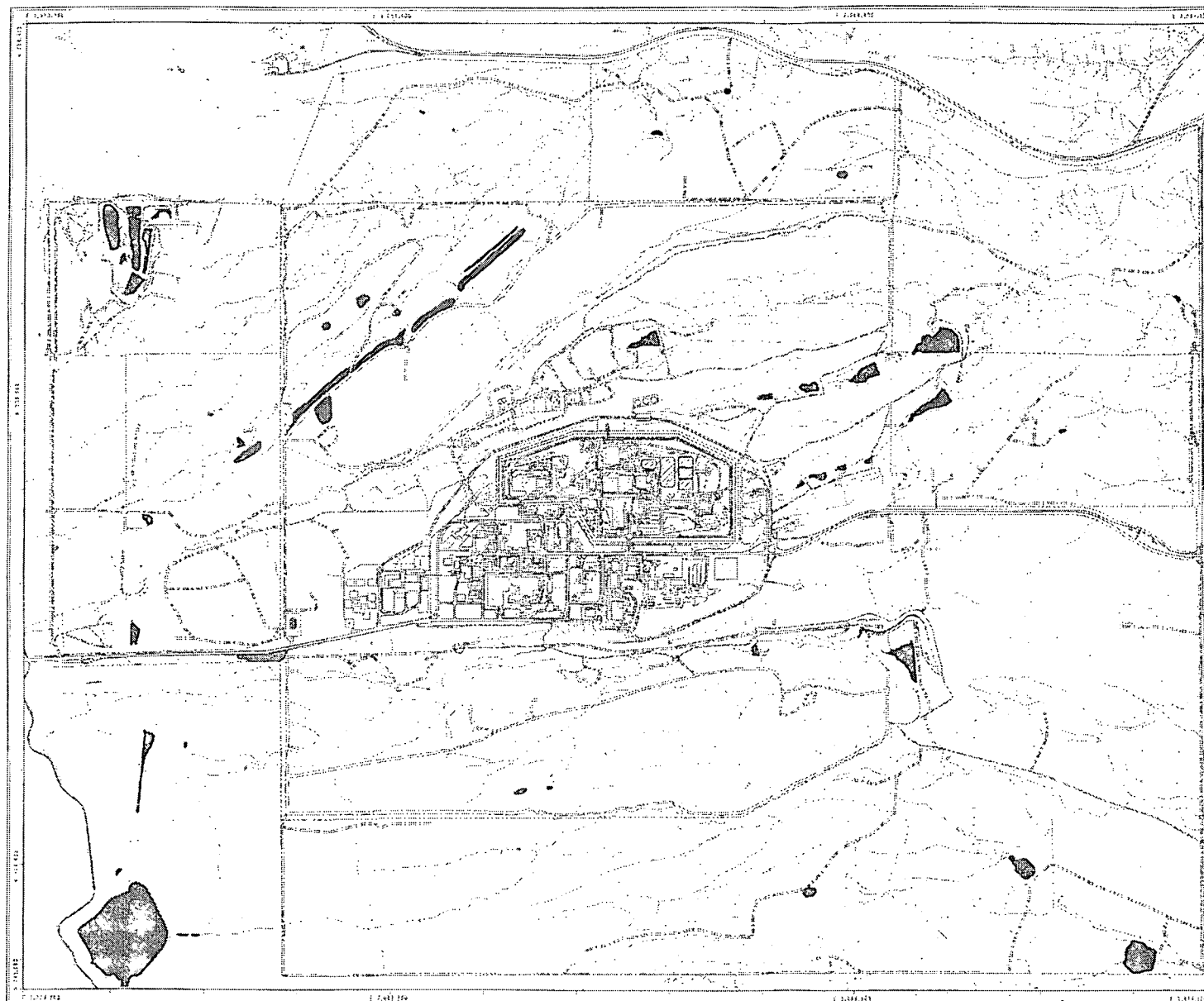
State Plane Coordinate Projection  
Colorado Central Zone  
Datum: NAD83

U.S. Department of Energy  
Rocky Flats Environmental Technology Site

Prepared by  
**Exponent**

MAP ID: Rnmr/S10565













April 28, 1998



**1997 Diffuse Knapweed  
(*Centaurea diffusa*) Distribution  
Figure 5-2**

**MAP LEGEND**

**Standard Map Features**

-  High Density Areas
-  Medium Density Areas
-  Low Density Areas
-  Scattered Density Areas
-  Buildings and other structures
-  Solar evaporation ponds
-  Lakes and ponds
-  Streams, ditches, or other drainage features
-  Fences and other barriers
-  Contour (20-Foot)
-  Paved roads
-  Dirt roads

DATA SOURCE:  
1997 Diffuse Knapweed Contours of Diffuse Knapweed  
Data Source: Data provided by the U.S. Department of Energy,  
Rocky Flats Environmental Technology Site. Data was collected from  
aerial photography and ground surveys. The data was processed and  
analyzed by Exponent, Inc. The data was then used to create the  
map and is not for distribution outside of the site.

Scale = 1 : 21030  
1 inch represents approximately 1778 feet

0 1000 2000

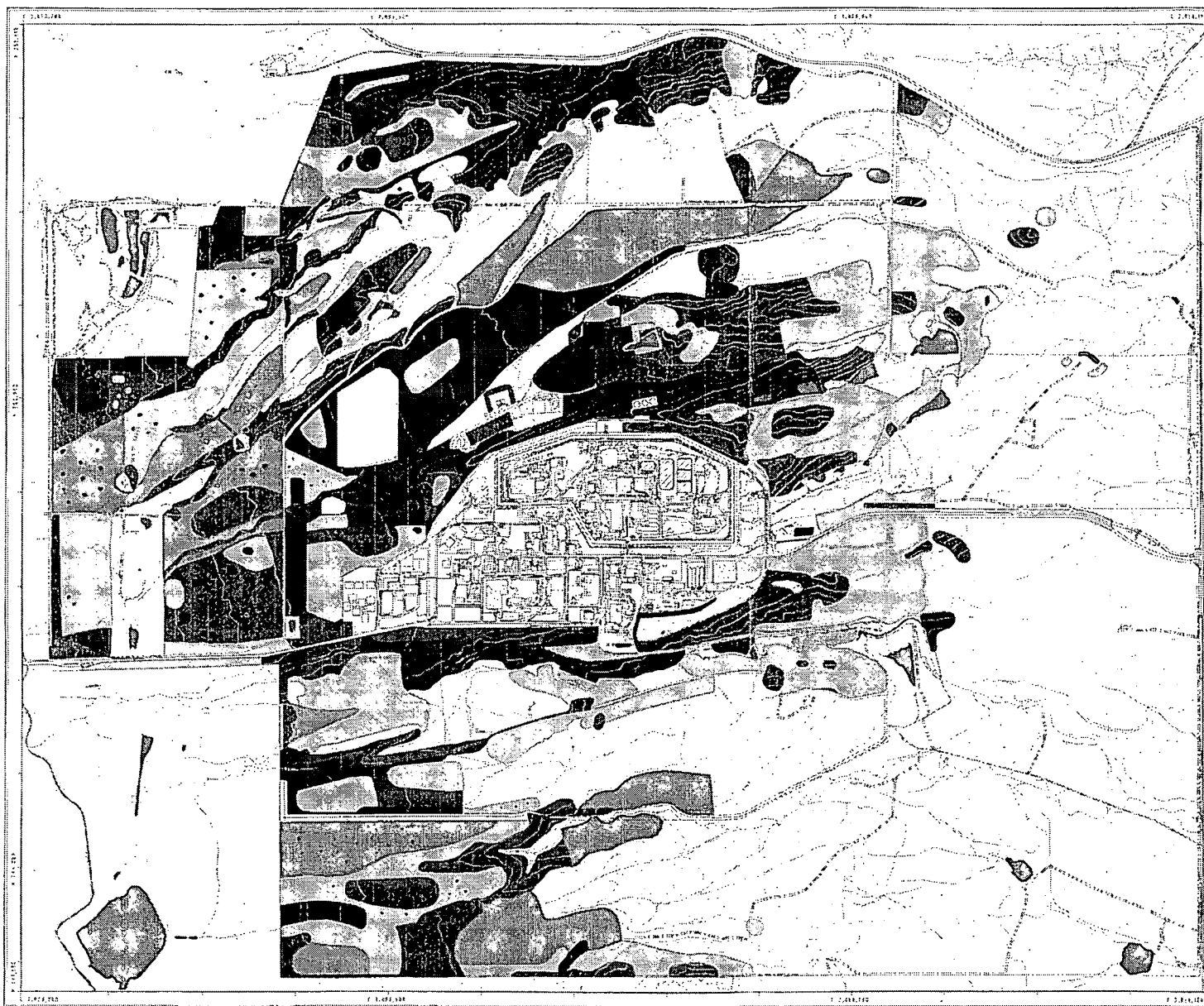
State Plane Coordinate Projection  
Colorado Central Zone  
Datum: NAD27

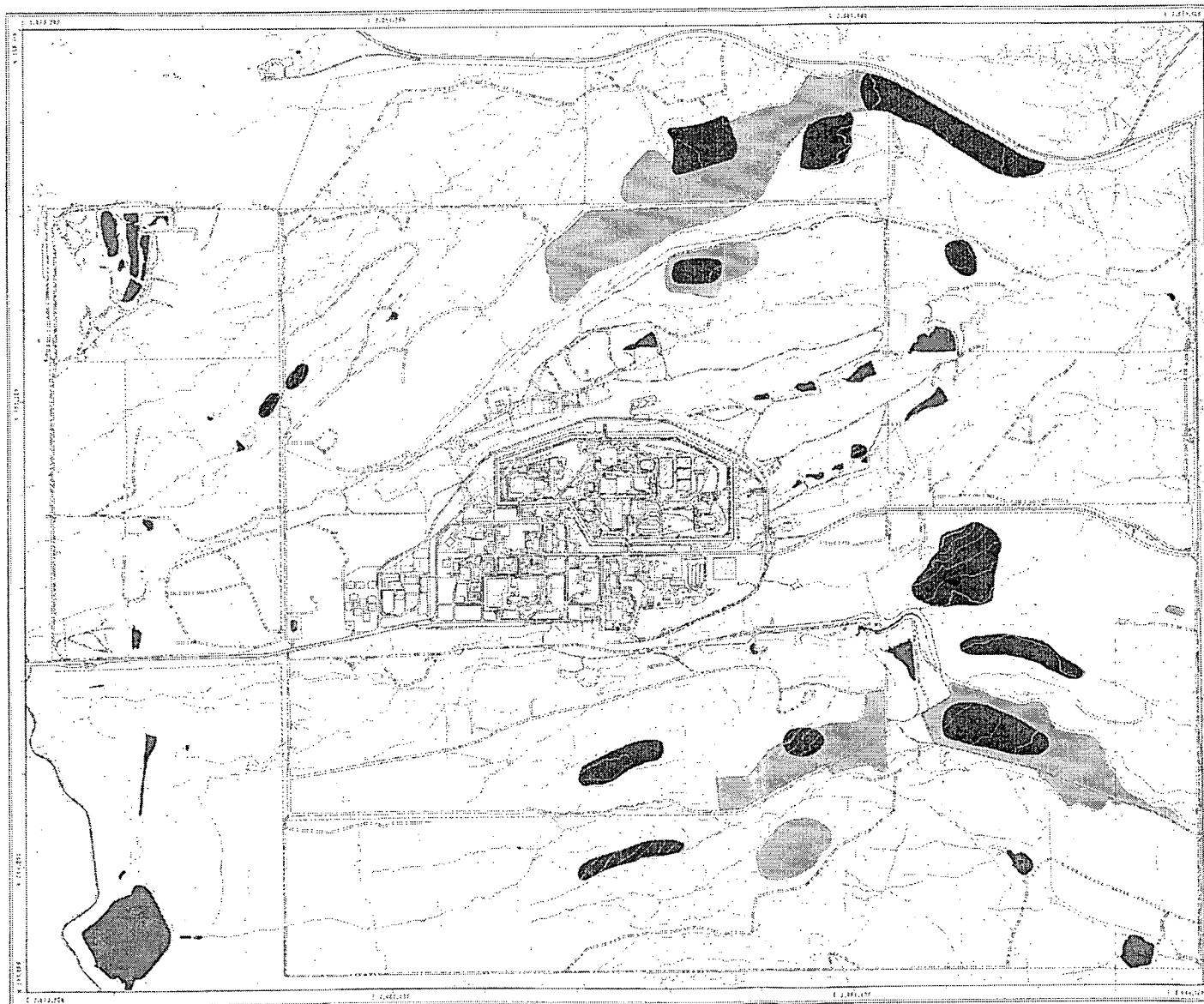
U.S. Department of Energy  
Rocky Flats Environmental Technology Site

Prepared by  
**Exponent**

MAP ID: Rfem6196657

April 28, 1998





**1997 Musk Thistle  
(*Carduus nutans*) Distribution  
Figure 5-3**

**MAP LEGEND**

**Standard Map Features**

- High Density Areas
- Medium Density Areas
- Low Density Areas
- Buildings and other structures
- Solar evaporation ponds
- Lakes and ponds
- Streams, ditches, or other drainage features
- Fences and other barriers
- Camoufl (20-Foot)
- Paved roads
- Dirt roads

DATA SOURCES:  
1997 Musk Thistle Distribution data was collected by Exponent  
Environmental Group.  
NOTE: These data represent only the locations  
of the plants. The distribution of the plants  
may not represent the population in the



Scale = 1 : 21330  
1 inch represents approximately 1775 feet



State Plane Coordinate Projection  
Colorado Central Zone  
Datum: NAD27

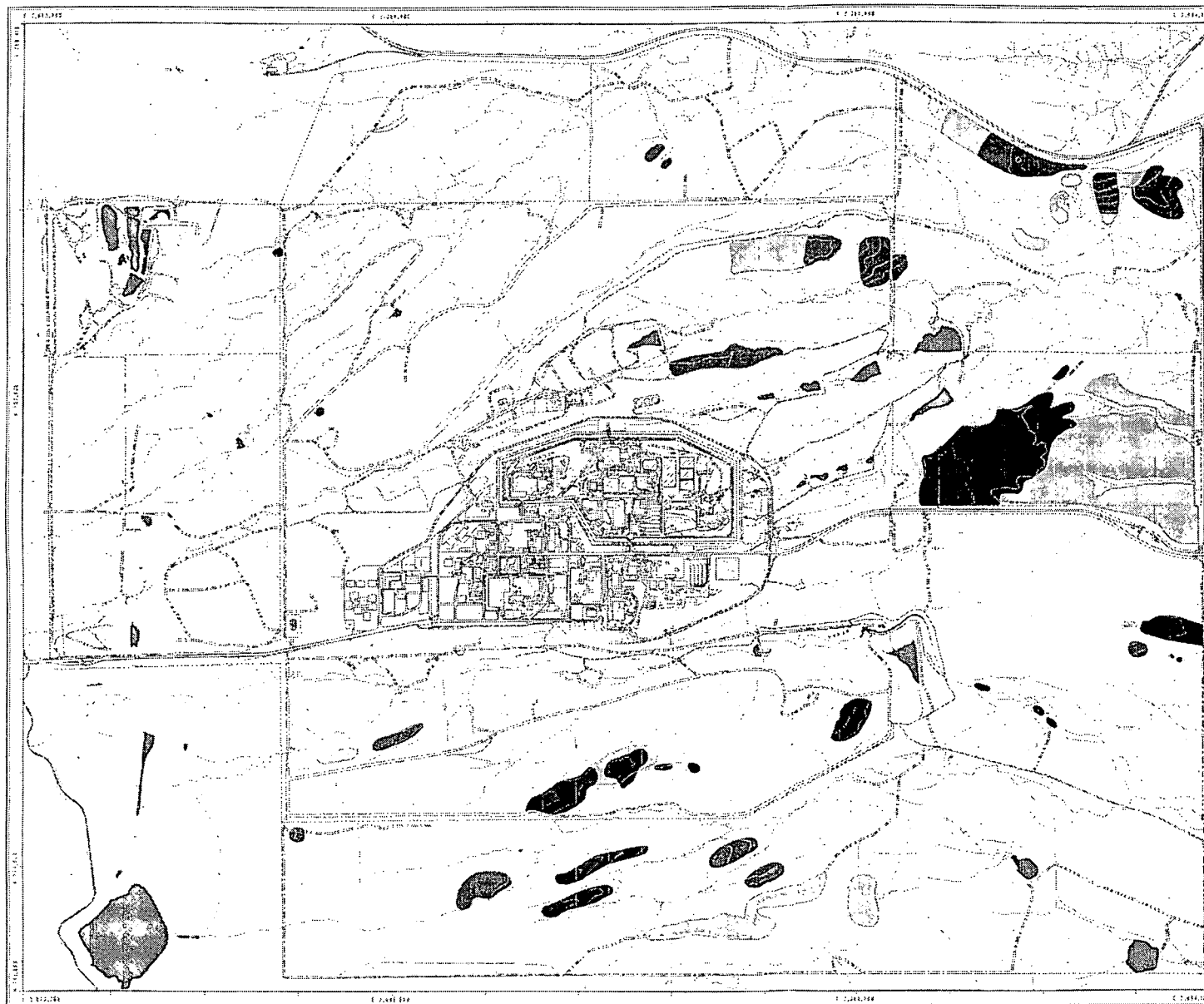
U.S. Department of Energy  
Rocky Flats Environmental Technology Site

Prepared by

**Exponent**

MAP ID: Home/1618665/

April 25, 1999



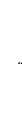
1997 Dalmatian Toadflax  
(*Linaria dalmatica*) Distribution  
Figure 5-4

MAP LEGEND

Standard Map Features

- High Density Areas
- Medium Density Areas
- Low Density Areas
- Buildings and other structures
- Solar evaporation ponds
- Lakes and ponds
- Streams, ditches, or other drainage features
- Fences and other barriers
- Contour (20-Foot)
- Paved roads
- Dirt roads

DATA SOURCES:  
1997 Dalmatian Toadflax density distribution  
maps, and distributions generated by Exponent  
and the U.S. Department of Energy, Rocky Flats  
Environmental Technology Site. The boundaries are  
based on aerial photography and ground truth. These  
areas may not represent all toadflax in the area.



Scale = 1 : 21330  
1 inch represents approximately 1778 feet



State Plane Coordinate Projection  
Colorado Central Zone  
Datum: NAD27

U.S. Department of Energy  
Rocky Flats Environmental Technology Site

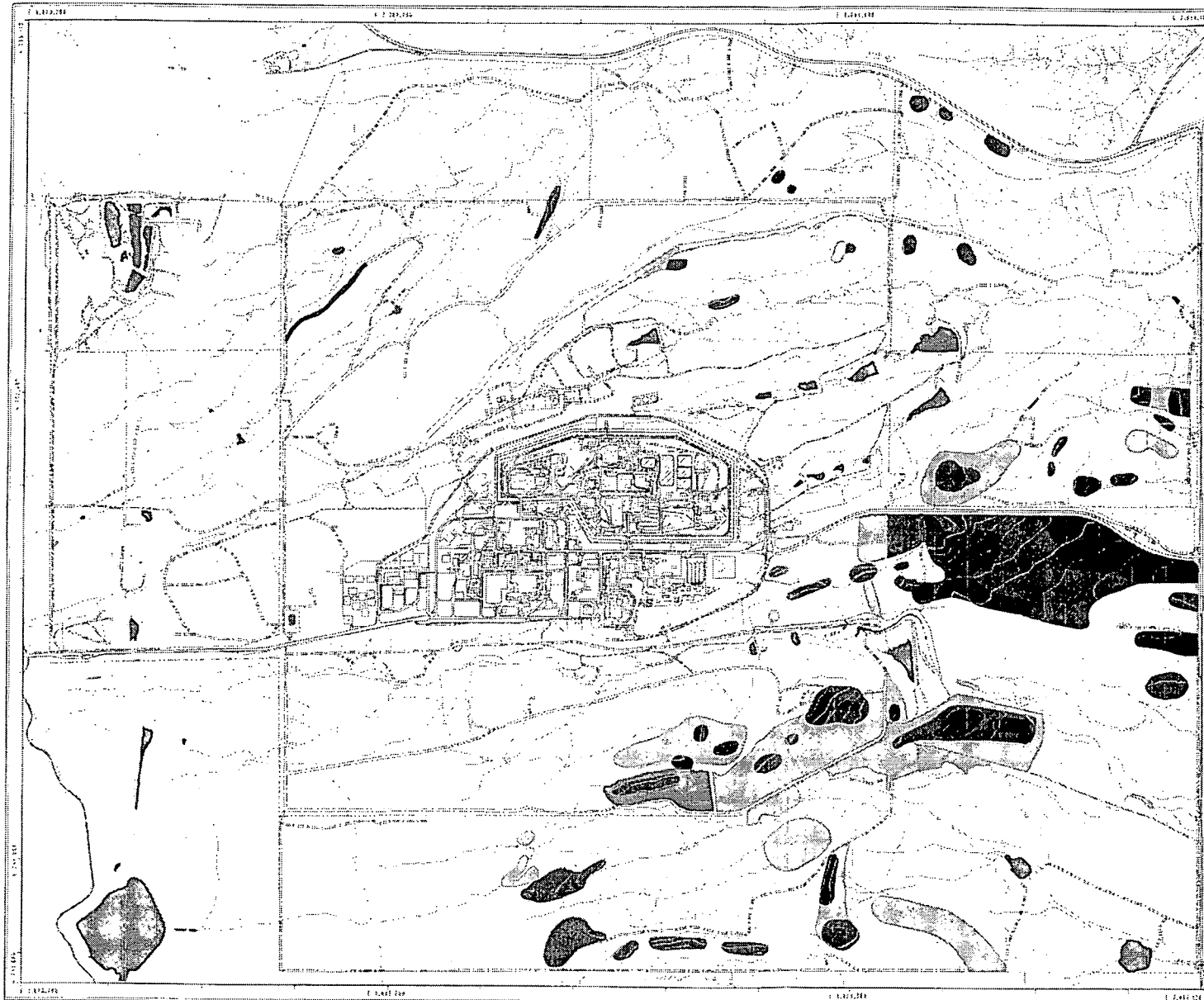
Prepared by

Exponent™

MAP ID: 700016106567

May 15, 1998

700016106567.dwg



1997 Mullein  
(Verbascum thapsus) Distribution  
Figure 5-5

MAP LEGEND

Standard Map Features

- High Density Areas
- Medium Density Areas
- Low Density Areas
- Scattered Density Areas
- Buildings and other structures
- Solar evaporation ponds
- Lakes and ponds
- Streams, ditches, or other drainage features
- Fences and other barriers
- Contour (20-Foot)
- Paved roads
- Dirt roads

DATA SOURCE:  
1997 Mullein (Verbascum thapsus) distribution data was collected by the Rocky Flats Environmental Technology Site, U.S. Department of Energy, Environmental Research Laboratory, during the summer of 1997. The data was collected by the Rocky Flats Environmental Technology Site, U.S. Department of Energy, Environmental Research Laboratory, during the summer of 1997. The data was collected by the Rocky Flats Environmental Technology Site, U.S. Department of Energy, Environmental Research Laboratory, during the summer of 1997.

Scale = 1 : 21330  
1 inch represents approximately 1778 feet

500 0 1000 2000

State Plane Coordinate Projection  
Colorado Central Zone  
Datum: NAD27

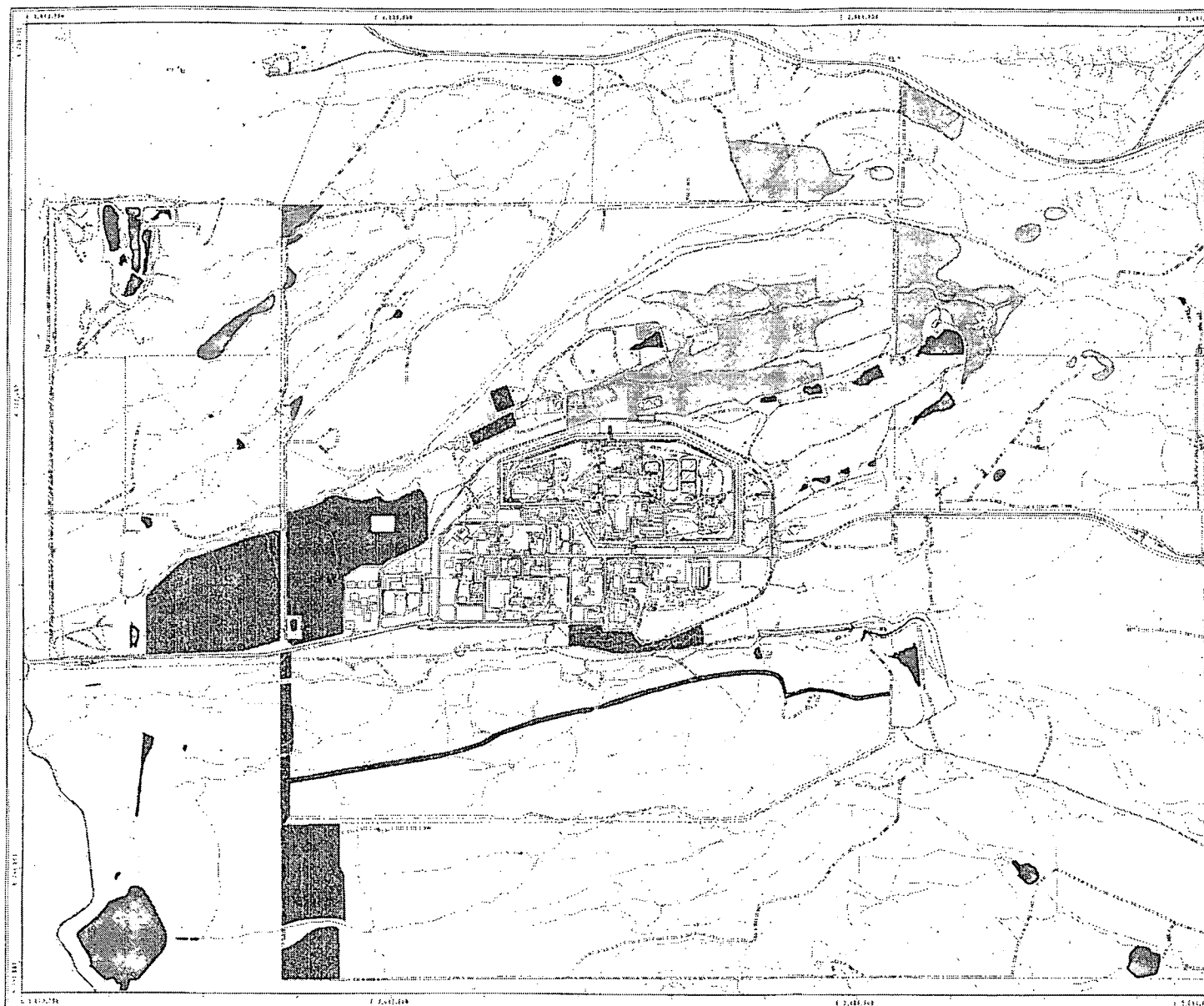
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Rocky Flats Environmental Technology Site

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Exponent™

MAP ID: rfoam/RS1905A

April 28, 1998



**FY1997-FY1998 Weed Control Efforts in the Buffer Zone**  
Figure 5-6

**MAP LEGEND**

**Standard Map Features**

- FY1987 - Truck/Tordon
- FY1987 - Truck/Transline
- FY1987 - Biocontrol/Diffuse Knapweed
- FY1987 - Biocontrol/Desmation Toxiflex
- FY1988 - Truck/Tordon
- Buildings and other structures
- Solar evaporation ponds
- Lakes and ponds
- Streams, ditches, or other drainage features
- Fences and other barriers
- Contour (20-Foot)
- Paved roads
- Dirt roads

DATE 3/28/98  
THIS Weed Control Effort Map is the  
Official Map of the Rocky Flats Environmental  
Technology Site prepared by Exponent  
Corporation. It is the property of Exponent  
Corporation. The boundaries are not  
guaranteed to be correct.



Scale = 1 : 21330  
1 inch represents approximately 1778 feet

0 1000 2000 3000 Feet

State Plane Coordinate Projection  
Colorado Central Zone  
Datum: NAD27

U.S. Department of Energy  
Rocky Flats Environmental Technology Site

**Exponent**

MAP ID: R000001066/

April 28, 1998

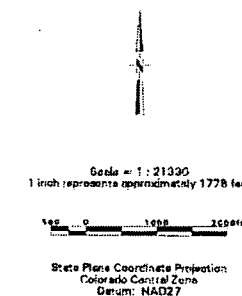
1997 High-Value Vegetation  
Photo Point Locations and ID Numbers  
Figure 5-7

MAP LEGEND

Standard Map Features

- Photo Point Locations and ID Numbers
- ▭ Buildings and other structures
- ▨ Solar evaporation ponds
- ▩ Lakes and ponds
- Streams, ditches, or other drainage features
- Fences and other barriers
- Contour (20-Foot)
- == Paved roads
- Dirt roads

DATA SOURCES:  
NOFIS Photo Point locations are based on  
aerial photograph interpretation. Other data sources  
are topographic maps and other maps. The photo  
point locations are based on the photo  
interpretation of the data.

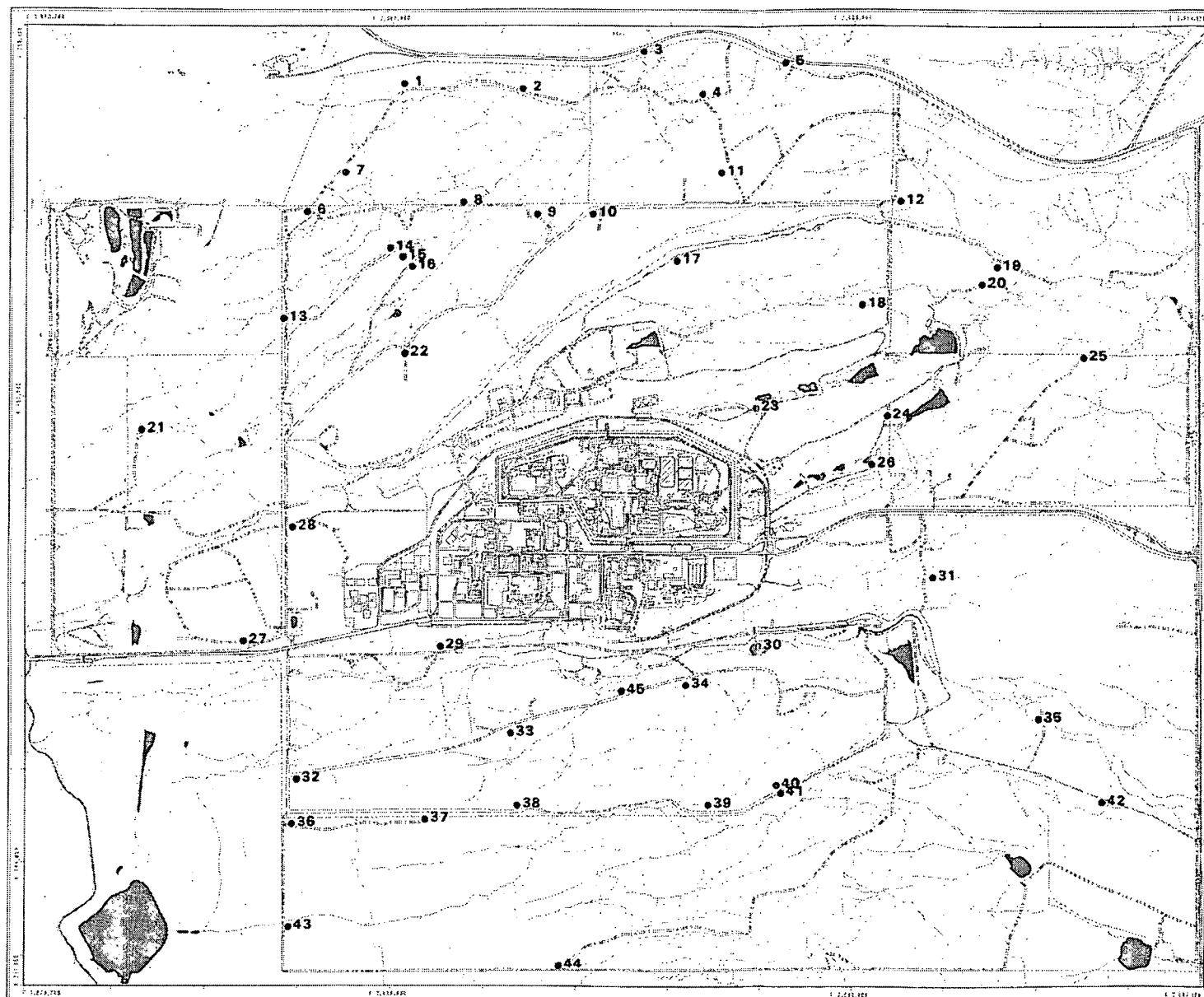


U.S. Department of Energy  
Rocky Flats Environmental Technology Site

Prepared by:  
**Exponent**

MAP ID: Roms/619056/

April 26, 1998





**Figure 5-8.** The great diversity of plant life found on the xeric tallgrass prairie at the Site provides habitat for numerous bird, small mammal, and insect species.



Figure 5-9. Porter's aster, broom snakeweed, and big bluestem are a few of the 274 species known to occur on the xeric tallgrass prairie at the Site.

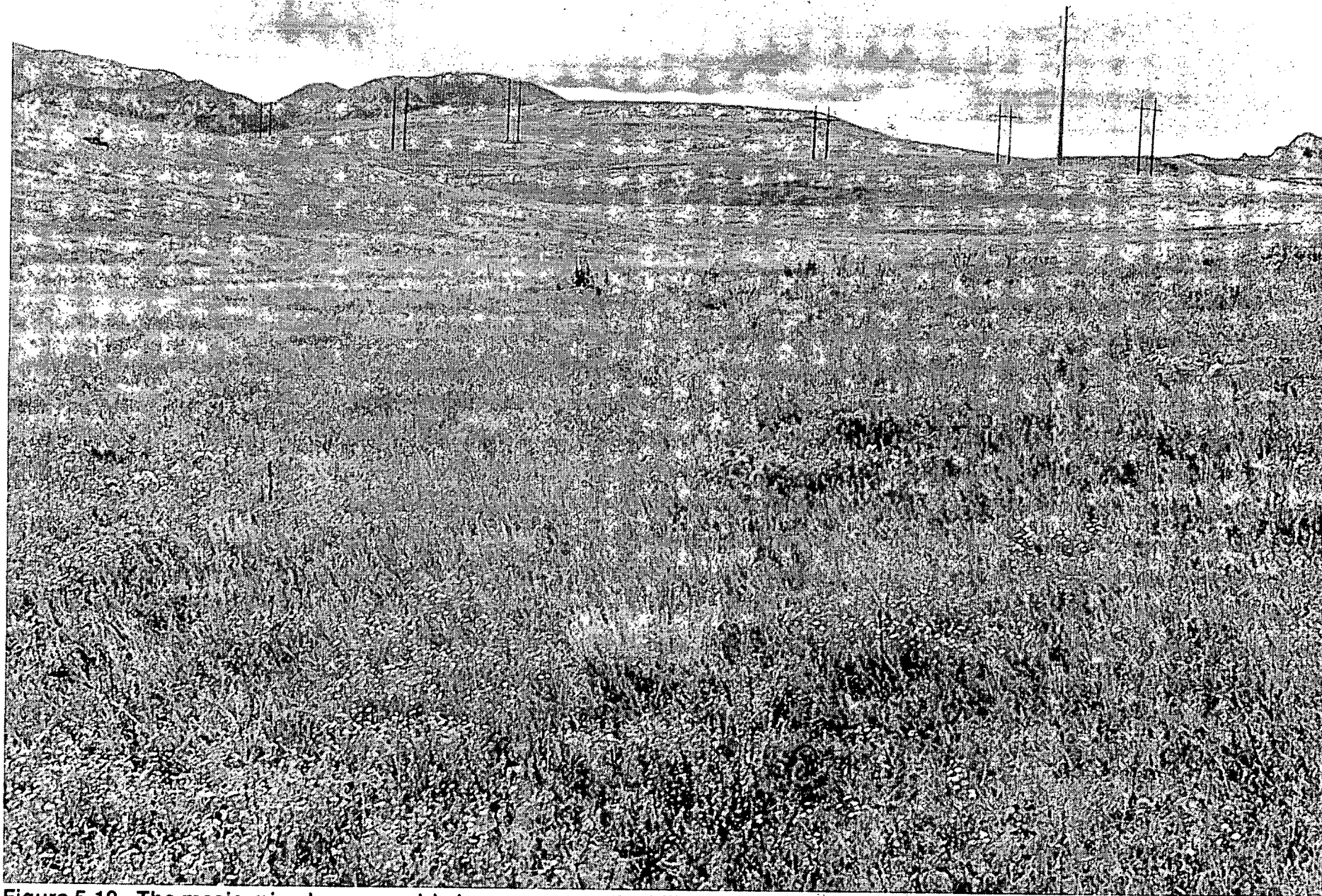


Figure 5-10. The mesic mixed grass prairie is common on the hillsides and lower elevations on Site.

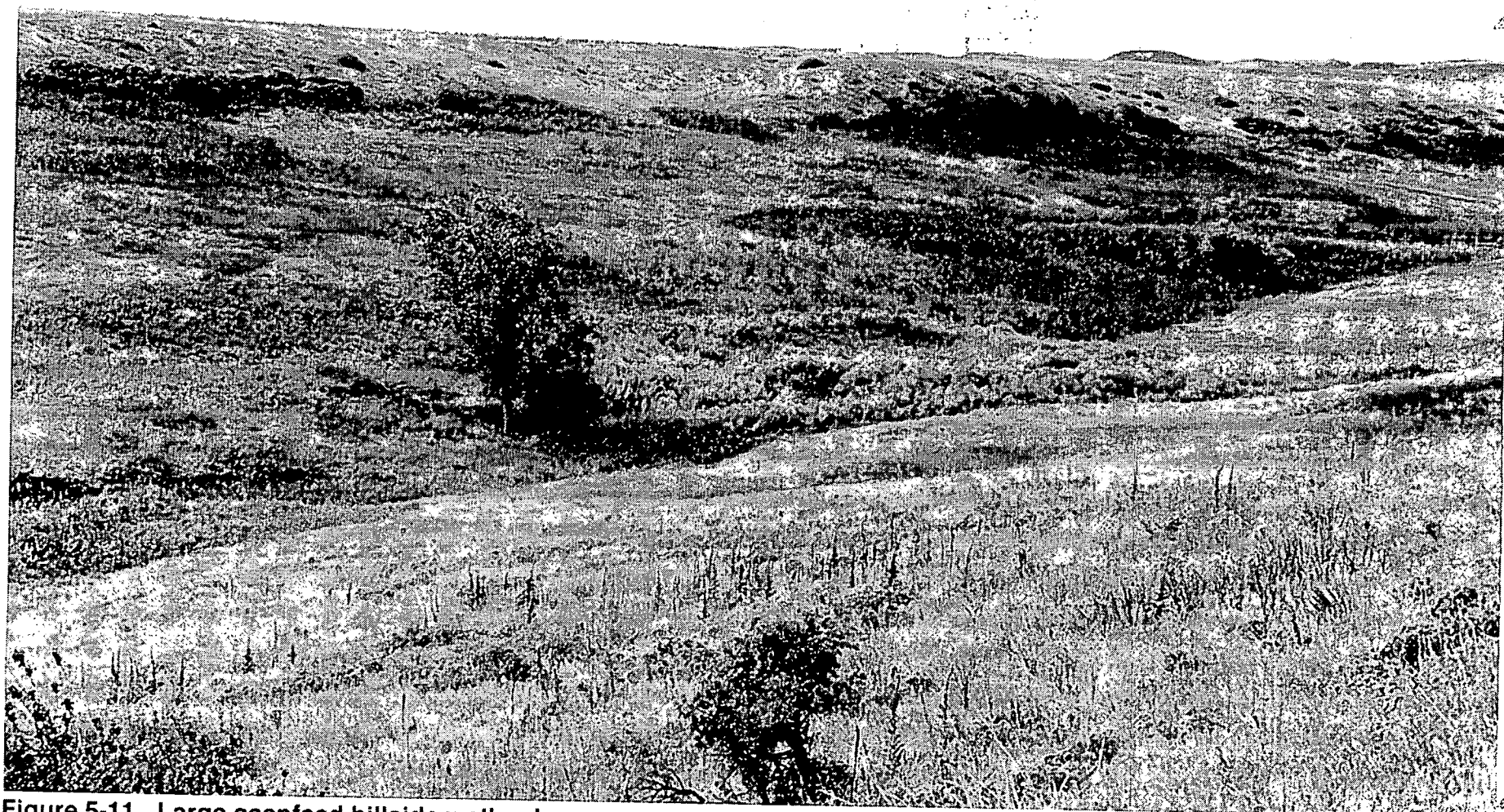
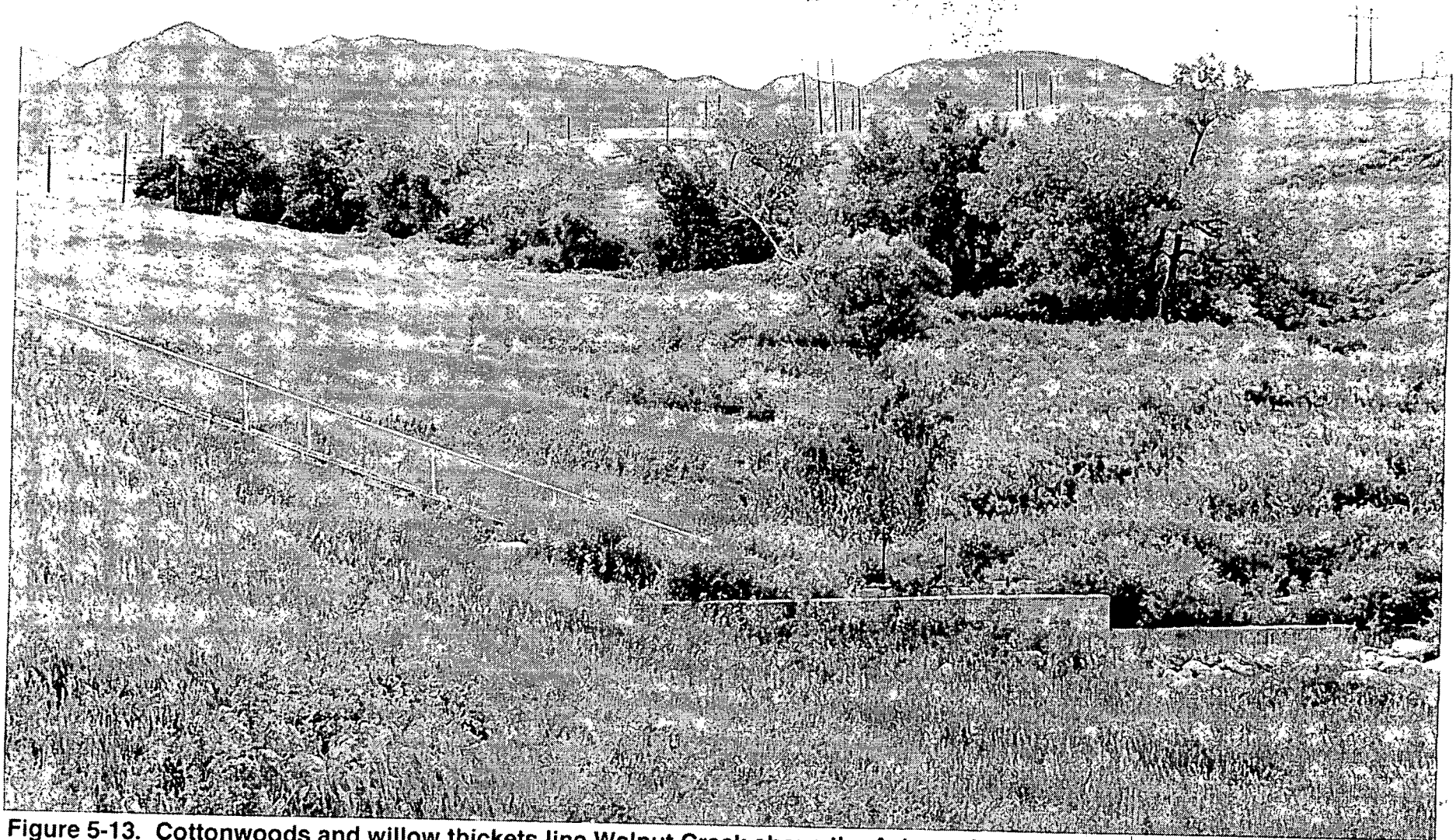


Figure 5-11. Large seepfeed hillside wetlands are common in the Rock Creek drainage on Site.



**Figure 5-12.** The tall upland shrubland composed primarily of a canopy of chokecherry, hawthorn, and American plum is abundant in the upper reaches of Rock Creek on Site and contains many species of plants found nowhere else on Site.



**Figure 5-13.** Cottonwoods and willow thickets line Walnut Creek above the A-1 pond and are typical of the Great Plains riparian woodland on Site.

**TABLE 5-1. 1997 HIGH-VALUE VEGETATION COMMUNITY  
SPECIES RICHNESS SUMMARY**

Variable	Xeric Tallgrass Prairie	Wetlands	Tall Upland Shrubland	Great Plains Riparian Woodland
Number of species	274	260	352	336
Number of families	55	59	66	65
Percent native species	81	77	82	77
Number of dicots	201	181	259	241
Number of monocots	68	78	87	91
Monocot/dicot ratio	0.34	0.43	0.34	0.38
Number of gymnosperms	4	0	4	2
Number of pteridophytes	1	1	2	2
Number of forbs	193	174	236	220
Number of graminoids	57	63	73	76
Number of cacti	5	3	5	5
Number of shrubs	11	11	21	17
Number of trees	8	8	15	16
Number of vines	0	1	2	2

TABLE 5-2. 1997 HIGH-VALUE PLANT COMMUNITY SPECIES RICHNESS

Family	Scientific Name	Speccode	Native	Xeric		Tall Upland	Great Plains
				Tallgrass	Wetlands	Shrubland	Riparian
				Prairie			Woodland
ACERACEAE	Acer glabrum Torr.	ACGL1	Y			X	
ACERACEAE	Acer negundo L. var. interius (Britt.) Sarg.	ACNE1	Y		X	X	X
AGAVACEAE	Yucca glauca Nutt.	YUGL1	Y	X	X	X	X
ALISMATACEAE	Alisma trivale Pursh	ALTR1	Y		X		X
ALISMATACEAE	Sagittaria latifolia Willd.	SALA1	Y		X	X	X
AMARANTHACEAE	Amaranthus graecizans L.	AMGR1	Y				X
ANACARDIACEAE	Rhus aromatica Ait. var. trilobata (Nutt.) A. Gray	RHAR1	Y	X	X	X	X
ANACARDIACEAE	Toxicodendron rydbergii (Small) Greene	TORY1	Y		X	X	X
APIACEAE	Cicuta maculata L. var. angustifolia Hook.	CIMA1	Y		X	X	X
APIACEAE	Conium maculatum L.	COMA1	N		X	X	X
APIACEAE	Daucus carota L.	DACA2	N	X			
APIACEAE	Harbouria trachypleura (Gray) C. & R.	HATR1	Y	X		X	
APIACEAE	Heracleum sphondylium L. ssp. montanum (Schleich.) Briq.	HESP1	Y		X	X	X
APIACEAE	Ligusticum porteri C. & R.	LIPO1	Y			X	
APIACEAE	Lomatium orientale Coult. & Rose	LOOR1	Y	X	X	X	X
APIACEAE	Musineon divaricatum (Pursh.) Nutt. var. hookeri T. & G.	MUDI1	Y	X		X	X
APIACEAE	Osmorhiza chiliensis H. & A.	OSCH1	Y			X	X
APIACEAE	Osmorhiza longistylis (Torr.) DC var. longistylis	OSLO1	Y			X	X
APOCYNACEAE	Apocynum cannabinum L.	APCA1	Y	X	X	X	X
ASCLEPIADACEAE	Asclepias incarnata L.	ASIN1	Y		X	X	X
ASCLEPIADACEAE	Asclepias pumila (Gray) Vail	ASPU1	Y	X			
ASCLEPIADACEAE	Asclepias speciosa Torr.	ASSP1	Y	X	X	X	X
ASCLEPIADACEAE	Asclepias stenophylla A. Gray	ASST1	Y	X	X		
ASCLEPIADACEAE	Asclepias viridiflora Raf.	ASVI1	Y	X		X	
ASTERACEAE	Achillea millefolium L. ssp. lanulosa (Nutt.) Piper	ACMI1	Y	X	X	X	X
ASTERACEAE	Ambrosia artemisiifolia L.	AMAR1	Y		X		
ASTERACEAE	Ambrosia psilostachya DC.	AMPS1	Y	X	X	X	X
ASTERACEAE	Ambrosia trifida L.	AMTR1	Y			X	X
ASTERACEAE	Antennaria microphylla Rydb.	ANMI1	Y	X		X	
ASTERACEAE	Antennaria parvifolia Nutt.	ANPA1	Y	X		X	
ASTERACEAE	Arctium minus Bernh.	ARMI1	Y		X	X	X
ASTERACEAE	Arnica fulgens Pursh.	ARFU1	Y	X	X	X	X
ASTERACEAE	Artemisia campestris L. ssp. caudata (Michx.) Hall & Clem.	ARCA1	Y	X		X	X
ASTERACEAE	Artemisia dracunculus L.	ARDR1	Y	X		X	X
ASTERACEAE	Artemisia frigida Willd.	ARFR1	Y	X	X	X	X
ASTERACEAE	Artemisia ludoviciana Nutt. var. ludoviciana	ARLU1	Y	X	X	X	X
ASTERACEAE	Aster falcatus Lindl.	ASFA1	Y	X	X	X	X
ASTERACEAE	Aster fendleri A. Gray	ASFE1	Y	X		X	
ASTERACEAE	Aster hesperius A. Gray var. hesperius	ASHE1	Y		X	X	X
ASTERACEAE	Aster laevis L. var. geyeri A. Gray	ASLA1	Y		X	X	
ASTERACEAE	Aster porteri Gray	ASPO1	Y	X	X	X	X

TABLE 5-2. (cont.)

Family	Scientific Name	Speccode	Native	Xeric Tallgrass		Tall Upland		Great Plains	
				Prairie	Wetlands	Shrubland	Woodland	Riparian	Woodland
ASTERACEAE	<i>Bidens frondosa</i> L.	BIFR1	Y			X		X	
ASTERACEAE	<i>Carduus nutans</i> L. ssp. <i>macrolepis</i> (Peters.) Kazmi	CANU1	N	X	X	X		X	
ASTERACEAE	<i>Centaurea diffusa</i> Lam.	CEDI1	N	X	X	X		X	
ASTERACEAE	<i>Chrysanthemum leucanthemum</i> L.	CHLE1	N					X	
ASTERACEAE	<i>Chrysopsis fulcrata</i> Greene	CHF11	Y	X	X	X		X	
ASTERACEAE	<i>Chrysopsis villosa</i> Pursh.	CHV11	Y	X	X	X		X	
ASTERACEAE	<i>Chrysothamnus nauseosus</i> (Pall.) Britt. ssp. <i>graveolens</i> (Nutt.) Piper	CHNA1	Y	X				X	
ASTERACEAE	<i>Chrysothamnus nauseosus</i> (Pall.) Britt. ssp. <i>nauseosus</i>	CHNA2	Y					X	
ASTERACEAE	<i>Cichorium intybus</i> L.	CIIN1	N	X		X		X	
ASTERACEAE	<i>Cirsium arvense</i> (L.) Scop.	CIAR1	N	X	X	X		X	
ASTERACEAE	<i>Cirsium undulatum</i> (Nutt.) Spreng.	CIUN1	Y	X		X		X	
ASTERACEAE	<i>Cirsium vulgare</i> (Savi) Ten.	CIVU1	N		X	X		X	
ASTERACEAE	<i>Conyza canadensis</i> (L.) Cronq.	COCA1	Y	X	X	X		X	
ASTERACEAE	<i>Crepis occidentalis</i> Nutt.	CROC1	Y			X			
ASTERACEAE	<i>Crepis runcinata</i> (James) T. & G.	CRRU1	Y		X				
ASTERACEAE	<i>Dyssodia papposa</i> (Vent) Hitchc.	DYPA1	N	X					
ASTERACEAE	<i>Erigeron canus</i> A. Gray	ERCA1	Y	X					
ASTERACEAE	<i>Erigeron compositus</i> Pursh var. <i>dicoideus</i> A. Gray	ERCO1	Y	X					
ASTERACEAE	<i>Erigeron divergens</i> T. & G.	ERDI1	Y	X	X	X		X	
ASTERACEAE	<i>Erigeron flagellaris</i> A. Gray	ERFL1	Y	X		X		X	
ASTERACEAE	<i>Erigeron speciosa</i> (Lindl.) DC. var. <i>macranthus</i> (Nutt.) Cronq.	ERSP1	Y			X			
ASTERACEAE	<i>Erigeron strigosus</i> Muhl. ex Willd.	ERST1	Y					X	
ASTERACEAE	<i>Erigeron vetensis</i> Rydb.	ERVE1	Y	X					
ASTERACEAE	<i>Gaillardia aristata</i> Pursh.	GAAR1	Y	X	X	X		X	
ASTERACEAE	<i>Gnaphalium chilense</i> Spreng.	GNCH1	Y		X	X			
ASTERACEAE	<i>Grindelia squarrosa</i> (Pursh.) Dun.	GRSQ1	Y	X	X	X		X	
ASTERACEAE	<i>Gutierrezia sarothrae</i> (Pursh.) Britt. & Rusby	GUSA1	Y	X	X	X		X	
ASTERACEAE	<i>Happlopappus spinulosus</i> (Pursh) DC.	HASP1	Y	X					
ASTERACEAE	<i>Helianthus annuus</i> L.	HEAN1	Y	X	X			X	
ASTERACEAE	<i>Helianthus maximiliani</i> Schrad.	HEMA1	Y					X	
ASTERACEAE	<i>Helianthus nuttallii</i> T. & G.	HENU1	Y		X	X		X	
ASTERACEAE	<i>Helianthus petiolaris</i> Nutt.	HEPE1	Y	X	X			X	
ASTERACEAE	<i>Helianthus pumilus</i> Nutt.	HEPU1	Y	X		X		X	
ASTERACEAE	<i>Helianthus rigidus</i> (Cass.) Desf. ssp. <i>subrhomboideus</i> (Rydb.) Heiser	HERI1	Y	X	X	X			
ASTERACEAE	<i>Heliomeris multiflora</i> Nuttall	HEMU1	Y			X		X	
ASTERACEAE	<i>Hymenopappus filifolius</i> Hook. var. <i>cinereus</i> (Rydb.) I. M. Johnst.	HYFI1	Y	X		X			
ASTERACEAE	<i>Iva axillaris</i> Pursh.	IVAX1	Y					X	
ASTERACEAE	<i>Kuhnia chlorolepis</i> Woot. & Standl.	KUCH1	Y					X	
ASTERACEAE	<i>Kuhnia eupatorioides</i> L.	KUEU1	Y	X	X	X		X	
ASTERACEAE	<i>Lactuca oblongifolia</i> Nutt.	LAOB1	Y			X		X	
ASTERACEAE	<i>Lactuca serriola</i> L.	LASE1	N	X	X	X		X	

TABLE 5-2. (cont.)

Family	Scientific Name	Speccode	Native	Xeric		Tall Upland	Great Plains	
				Tallgrass	Wetlands		Riparian	Woodland
ASTERACEAE	Leucelene ericoides (Torr.) Greene	LEER1	Y	X				
ASTERACEAE	Liatris punctata Hook.	LIPU1	Y	X	X	X		X
ASTERACEAE	Machaeranthera canescens (Pursh) A. Gray	MACA1	Y	X				
ASTERACEAE	Microseris cuspidata (Pursh.) Sch. Bip.	MICU1	Y	X				
ASTERACEAE	Ratibida columnifera (Nutt.) Woot. & Standl.	RACO1	Y	X	X	X		X
ASTERACEAE	Scorzonera laciniata L.	SCLA1	N	X	X	X		X
ASTERACEAE	Senecio fendleri Gray	SEFE1	Y	X		X		
ASTERACEAE	Senecio integerrimus Nutt.	SEIN1	Y	X		X		X
ASTERACEAE	Senecio plattensis Nutt.	SEPL1	Y	X	X	X		X
ASTERACEAE	Senecio spartioides T. & G.	SESP1	Y	X		X		X
ASTERACEAE	Solidago canadensis L.	SOCA1	Y		X	X		X
ASTERACEAE	Solidago gigantea Ait.	SOGI1	Y		X	X		X
ASTERACEAE	Solidago missouriensis Nutt.	SOMI1	Y	X	X	X		X
ASTERACEAE	Solidago mollis Bart.	SOMO1	Y	X		X		
ASTERACEAE	Solidago rigida L.	SORI1	Y	X	X	X		X
ASTERACEAE	Sonchus arvensis L. ssp. uglinosus (Bieb.) Nyman	SOAR2	N					X
ASTERACEAE	Sonchus asper (L.) Hill	SOAS1	N		X	X		X
ASTERACEAE	Stephanomeria pauciflora (Torr.) A. Nels.	STPA1	Y					X
ASTERACEAE	Taraxacum officinale Weber	TAOF1	N	X	X	X		X
ASTERACEAE	Thelesperma megapotanicum (Spreng.) O. Ktze.	THME1	Y	X		X		
ASTERACEAE	Townsendia grandiflora (Nutt.)	TOGR1	Y			X		
ASTERACEAE	Townsendia hookeri Beaman	TOHO1	Y	X		X		
ASTERACEAE	Tragopogon dubius Scop.	TRDU1	N	X	X	X		X
ASTERACEAE	Tragopogon porrifolius L.	TRPO1	N		X			
ASTERACEAE	Xanthium strumarium L.	XAST1	Y					X
BERBERIDACEAE	Berberis repens Lindl.	BERE1	Y			X		X
BETULACEAE	Alnus incana (L.) Moench ssp. tenuifolia (Nuttall) Breitung	ALIN1	Y					X
BETULACEAE	Betula occidentalis Hook.	BEOC1	Y			X		
BORAGINACEAE	Asperugo procumbens L.	ASPR1	N			X		
BORAGINACEAE	Cryptantha virgata (Porter) Payson	CRVI1	Y	X				
BORAGINACEAE	Cynoglossum officinale L.	CYOF1	N		X	X		X
BORAGINACEAE	Hackelia floribunda (Lehm.) I. M. Johnst.	HAFL1	Y			X		
BORAGINACEAE	Lappula redowskii (Hornem.) Greene	LARE1	Y	X		X		
BORAGINACEAE	Lithospermum incisum Lehm.	LIIN1	Y	X				X
BORAGINACEAE	Lithospermum multiflorum Torr.	LIMU1	Y			X		
BORAGINACEAE	Mertensia lanceolata (Pursh.) A. DC.	MELA1	Y	X	X	X		X
BORAGINACEAE	Onosmodium molle Michx. var. occidentale (Mack.) Johnst.	ONMO1	Y	X	X	X		X
BRASSICACEAE	Alyssum alyssoides (L.) L.	ALAL1	N	X	X	X		X
BRASSICACEAE	Alyssum minus (L.) Rothmaler var. micranthus (C. A. Mey.) Dudley	ALMI1	N	X	X	X		X
BRASSICACEAE	Arabis fendleri (S. Wats.) Greene var. fendleri	ARFE3	Y	X		X		
BRASSICACEAE	Arabis glabra (L.) Bernh.	ARGL1	N		X	X		X

TABLE 5-2. (cont.)

Family	Scientific Name	Speccode	Native	Xeric Tallgrass		Tall Upland Shrubland	Great Plains	
				Prairie	Wetlands		Riparian Woodland	
BRASSICACEAE	<i>Arabis hirsuta</i> (L.) Scop. var. <i>pynocarpa</i> (Hopkins) Rollins	ARHI1	Y	X	X			
BRASSICACEAE	<i>Barbarea vulgaris</i> R. Br.	BAVU1	N	X	X	X		X
BRASSICACEAE	<i>Camelina microcarpa</i> Andr. ex DC.	CAMI1	N	X	X	X		X
BRASSICACEAE	<i>Conringia orientalis</i> (L.) Dum.	COOR1	N					X
BRASSICACEAE	<i>Descurainia pinnata</i> (Walt.) Britt.	DEPI1	Y	X	X	X		X
BRASSICACEAE	<i>Descurainia richardsonii</i> (Sweet) Schultz	DERI1	Y	X	X	X		X
BRASSICACEAE	<i>Descurainia sophia</i> (L.) Webb ex Prantl.	DESO1	N		X	X		X
BRASSICACEAE	<i>Draba nemorosa</i> L.	DRNE1	Y	X		X		
BRASSICACEAE	<i>Draba reptans</i> (Lam.) Fern.	DRRE1	Y	X				
BRASSICACEAE	<i>Erysimum capitatum</i> (Nutt.) DC.	ERCA2	Y	X		X		
BRASSICACEAE	<i>Erysimum repandum</i> L.	ERRE1	N					X
BRASSICACEAE	<i>Hesperis matronalis</i> L.	HEMA2	N					X
BRASSICACEAE	<i>Lepidium campestre</i> (L.) R. Br.	LECA1	N	X	X	X		X
BRASSICACEAE	<i>Lepidium densiflorum</i> Schrad.	LEDE1	Y	X		X		
BRASSICACEAE	<i>Lesquerella montana</i> (A. Gray) Wats.	LEMO1	Y	X		X		
BRASSICACEAE	<i>Nasturtium officinale</i> R. Br.	NAOF1	N		X	X		X
BRASSICACEAE	<i>Physaria vitulifera</i> Rydb.	PHVI1	Y					X
BRASSICACEAE	<i>Sisymbrium altissimum</i> L.	SIAL1	N	X	X	X		X
BRASSICACEAE	<i>Thlaspi arvense</i> L.	THAR1	N		X	X		X
CACTACEAE	<i>Coryphantha missouriensis</i> (Sweet) Britt. & Rose	COMI1	Y	X		X		X
CACTACEAE	<i>Echinocereus viridiflorus</i> Engelm.	ECVI1	Y	X		X		X
CACTACEAE	<i>Opuntia fragilis</i> (Nutt.) Haw.	OPFR1	Y	X	X	X		X
CACTACEAE	<i>Opuntia macrorhiza</i> Engelm.	OPMA1	Y	X	X	X		X
CACTACEAE	<i>Pediocactus simpsonii</i> (Engelm.) Britt. & Rose	PESI1	Y	X	X	X		X
CAMPANULACEAE	<i>Campanula rotundifolia</i> L.	CARO1	Y	X	X	X		
CAMPANULACEAE	<i>Lobelia siphilitica</i> L. var. <i>ludoviciana</i> A. DC.	LOSI1	Y		X	X		
CANNABACEAE	<i>Humulus lupulus</i> L. var. <i>lupuloides</i> E. Small	HULU1	Y		X	X		X
CAPRIFOLIACEAE	<i>Symphoricarpos occidentalis</i> Hook.	SYOC1	Y	X	X	X		X
CAPRIFOLIACEAE	<i>Symphoricarpos oreophilus</i> Gray	SYOR1	Y			X		X
CAPRIFOLIACEAE	<i>Viburnum opulus</i> L. var. <i>americanum</i> Ait	VIOP1	N		X	X		
CARYOPHYLLACEAE	<i>Arenaria fendleri</i> A. Gray	ARFE2	Y	X	X	X		
CARYOPHYLLACEAE	<i>Cerastium arvense</i> L.	CEAR1	Y	X	X	X		X
CARYOPHYLLACEAE	<i>Cerastium vulgatum</i> L.	CEVU1	N		X	X		X
CARYOPHYLLACEAE	<i>Paronychia jamesii</i> T. & G.	PAJA1	Y	X		X		X
CARYOPHYLLACEAE	<i>Saponaria officinalis</i> L.	SAOF1	N			X		X
CARYOPHYLLACEAE	<i>Silene antirrhina</i> L.	SIAN1	Y	X	X	X		X
CARYOPHYLLACEAE	<i>Silene drummondii</i> Hook.	SIDR1	Y	X		X		X
CARYOPHYLLACEAE	<i>Silene pratensis</i> (Raf.) Godr. & Gren	SIPR1	N		X	X		X
CARYOPHYLLACEAE	<i>Spergularia rubra</i> (L.) K. Presl.	SPRU1	N	X				
CARYOPHYLLACEAE	<i>Stellaria longifolia</i> Muhl. ex Willd.	STLO1	Y		X	X		
CARYOPHYLLACEAE	<i>Vaccaria pyramidata</i> Medic.	VAPY1	N					X

TABLE 5-2. (cont.)

Family	Scientific Name	Speccode	Native	Xeric		Tall Upland	Great Plains	
				Tallgrass	Wetlands	Shrubland	Riparian	Woodland
CERATOPHYLLACEAE	Ceratophyllum demersum L.	CEDE1	Y		X			X
CHENOPODIACEAE	Chenopodium album L.	CHAL1	N		X			X
CHENOPODIACEAE	Chenopodium fremontii S. Wats.	CHFR1	Y			X		
CHENOPODIACEAE	Chenopodium leptophyllum Nutt. ex Moq.	CHLE2	Y	X		X		
CHENOPODIACEAE	Chenopodium overi Aellen	CHOV1	Y			X		
CHENOPODIACEAE	Kochia scoparia (L.) Schrad.	KOSC1	N					X
CHENOPODIACEAE	Salsola iberica Senn. & Pau.	SAIB1	N	X				X
CLUSIACEAE	Hypericum majus (A. Gray) Britt.	HYMA1	Y		X			
CLUSIACEAE	Hypericum perforatum L.	HYPE1	N	X	X	X		X
COMMELINACEAE	Tradescantia occidentalis (Britt.) Smyth	TROC1	Y	X	X	X		X
CONVOLVULACEAE	Convolvulus arvensis L.	COAR1	N	X	X	X		X
CONVOLVULACEAE	Evolvulus nuttallianus R. & S.	EVNU1	Y	X				X
CRASSULACEAE	Sedum lanceolatum Torr.	SELA1	Y	X		X		X
CUPRESSACEAE	Juniperus communis L.	JUCO1	Y	X		X		
CUPRESSACEAE	Juniperus scopulorum Sarg.	JUSC1	T	X		X		X
CYPERACEAE	Carex aurea Nutt.	CAAU1	Y			X		
CYPERACEAE	Carex brevior (Dew.) Mack. ex Lunell.	CABR1	Y		X	X		X
CYPERACEAE	Carex eleocharis Bailey	CAEL1	Y	X	X	X		X
CYPERACEAE	Carex filifolia Nutt.	CAFI1	Y	X				
CYPERACEAE	Carex heliophila Mack.	CAHE1	Y	X	X	X		X
CYPERACEAE	Carex hystericina Muhl. ex Willd.	CAHY1	Y		X	X		X
CYPERACEAE	Carex interior Bailey	CAIN1	Y	X	X	X		
CYPERACEAE	Carex lanuginosa Michx.	CALA1	Y		X	X		X
CYPERACEAE	Carex nebrascensis Dew.	CANE1	Y		X	X		X
CYPERACEAE	Carex oreocharis Holm.	CAOR1	Y	X		X		
CYPERACEAE	Carex praegracilis W. Boott.	CAPR1	Y	X	X	X		X
CYPERACEAE	Carex scoparia Schkuhr. ex Willd.	CASC1	Y		X	X		X
CYPERACEAE	Carex simulata Mack.	CASI1	Y		X	X		X
CYPERACEAE	Carex stipata Muhl.	CAST1	Y			X		X
CYPERACEAE	Carex vulpinoidea Michx.	CAVU1	Y					X
CYPERACEAE	Eleocharis acicularis (L.) R. & S.	ELAC1	Y		X			X
CYPERACEAE	Eleocharis compressa Sulliv.	ELCO1	Y	X	X			X
CYPERACEAE	Eleocharis macrostachya Britt.	ELMA1	Y	X	X	X		X
CYPERACEAE	Scirpus pallidus (Britt.) Fern	SCPA1	Y		X	X		X
CYPERACEAE	Scirpus pungens Vahl	SCAM1	Y		X			X
CYPERACEAE	Scirpus validus Vahl.	SCVA1	Y		X	X		X
ELAEAGNACEAE	Elaeagnus angustifolia L.	ELAN1	N		X			X
EQUISETACEAE	Equisetum arvense L.	EQAR1	Y					X
EQUISETACEAE	Equisetum laevigatum A. Br.	EQLA1	Y		X	X		X
EUPHORBIACEAE	Euphorbia dentata Michx.	EUDE1	Y					X
EUPHORBIACEAE	Euphorbia fendleri T. & G.	EUFE1	Y	X				

TABLE 5-2. (cont.)

Family	Scientific Name	Speccode	Native	Xeric		Tall Upland	Great Plains
				Tallgrass	Wetlands	Shrubland	Riparian
EUPHORBIACEAE	Euphorbia robusta (Engelm.) Small	EURO1	Y	X		X	
EUPHORBIACEAE	Euphorbia serpyllifolia Pers.	EUSE1	Y		X		X
EUPHORBIACEAE	Euphorbia spathulata Lam.	EUSP1	Y	X		X	
EUPHORBIACEAE	Tragia ramosa Nutt.	TRRA1	Y	X			
FABACEAE	Amorpha fruticosa L.	AMFR1	Y	X	X	X	X
FABACEAE	Astragalus adsurgens Pall. var. robustior Hook.	ASAD1	Y	X		X	
FABACEAE	Astragalus agrestis Dougl. ex G. Don	ASAG1	Y	X	X	X	X
FABACEAE	Astragalus canadensis L.	ASCA1	Y			X	X
FABACEAE	Astragalus crassicaupus Nutt.	ASCR1	Y				X
FABACEAE	Astragalus drummondii Dougl. ex Hook.	ASDR1	Y	X	X	X	X
FABACEAE	Astragalus flexuosus (Hook.) G. Don	ASFL1	Y	X	X	X	X
FABACEAE	Astragalus shortianus Nutt. ex T.&G.	ASSH1	Y	X		X	X
FABACEAE	Astragalus tridactylus Gray	ASTR1	Y	X		X	
FABACEAE	Dalea candida Michx. ex Willd. var. oligophylla (Torr.) Shinnars.	DACA1	Y	X	X	X	X
FABACEAE	Dalea purpurea Vent	DAPU1	Y	X	X	X	X
FABACEAE	Glycyrrhiza lepidota Pursh.	GLLE1	Y	X	X	X	X
FABACEAE	Lathyrus eucosmus Butters and St. John	LAEU1	Y		X	X	X
FABACEAE	Lupinus argenteus Pursh ssp. ingratus (Greene) Harmon	LUAR2	Y			X	X
FABACEAE	Lupinus argenteus Pursh var. argenteus	LUAR1	Y	X	X	X	X
FABACEAE	Medicago lupulina L.	MELU1	N		X		X
FABACEAE	Medicago sativa L. ssp. sativa	MESA1	N	X			X
FABACEAE	Melilotus alba Medic.	MEAL1	N		X		X
FABACEAE	Melilotus officinalis (L.) Pall.	MEOF1	N	X		X	X
FABACEAE	Oxytropis lambertii Pursh.	OXLA1	Y	X	X	X	X
FABACEAE	Psoralea tenuiflora Pursh.	PSTE1	Y	X	X	X	X
FABACEAE	Robinia pseudo-acacia L.	ROPS1	N	X			
FABACEAE	Thermopsis rhombifolia var. divaricarpa (Nels.) Isely	THRH1	Y	X	X	X	X
FABACEAE	Vicia americana Muhl. ex Willd.	VIAM1	Y		X	X	X
GENTIANACEAE	Gentiana affinis Griseb.	GEAF1	Y	X	X	X	X
GENTIANACEAE	Swertia radiata (Kell.) O. Ktze.	SWRA1	Y	X	X	X	
GERANIACEAE	Erodium cicutarium (L.) L'Her.	ERCH1	N	X	X	X	X
GERANIACEAE	Geranium caespitosum James ssp. caespitosum	GECA1	Y	X	X	X	X
GROSSULARIACEAE	Ribes aureum Pursh	RIAU1	Y	X	X	X	X
GROSSULARIACEAE	Ribes cereum Dougl.	RICE1	Y	X		X	X
HALORAGACEAE	Myriophyllum exalbesens Fern.	MYEX1	Y		X		
HYDROPHYLLACEAE	Hydrophyllum fendleri (Gray) Heller	HYFE1	Y		X	X	X
HYDROPHYLLACEAE	Phacelia heterophylla Pursh.	PHHE1	Y	X	X	X	X
IRIDACEAE	Iris missouriensis Nutt.	IRMI1	Y	X	X	X	X
IRIDACEAE	Sisyrinchium montanum Greene	SIMO1	Y	X	X	X	X
JUNCACEAE	Juncus balticus Willd.	JUBA1	Y	X	X	X	X
JUNCACEAE	Juncus dudleyi Wieg.	JUDU1	Y	X	X	X	X

TABLE 5-2. (cont.)

Family	Scientific Name	Speccode	Native	Xeric		Tall Upland		Great Plains	
				Tallgrass	Wetlands	Prairie	Shrubland	Riparian	Woodland
JUNCACEAE	Juncus ensifolius Wikst. var. montanus (Englm.) C. L. Hitchc.	JUEN1	Y		X		X		X
JUNCACEAE	Juncus interior Wieg.	JUIN1	Y	X	X		X		X
JUNCACEAE	Juncus longistylis Torr.	JULO1	Y	X	X		X		X
JUNCACEAE	Juncus nodosus L.	JUNO1	Y		X		X		X
JUNCACEAE	Juncus torreyi Cov.	JUTO1	Y		X				X
LAMIACEAE	Hedeoma hispidum Pursh.	HEHI1	Y	X					
LAMIACEAE	Lycopus americanus Muhl. ex Barton	LYAM1	Y		X		X		X
LAMIACEAE	Marrubium vulgare L.	MAVU1	N	X			X		X
LAMIACEAE	Mentha arvensis L.	MEAR1	Y		X		X		X
LAMIACEAE	Monarda fistulosa L. var. menthifolia (Grah.) Fern.	MOFI1	Y	X	X		X		X
LAMIACEAE	Nepeta cataria L.	NECA1	N		X		X		X
LAMIACEAE	Prunella vulgaris L.	PRVU1	Y		X		X		X
LAMIACEAE	Scutellaria brittonii Porter	SCBR1	Y	X			X		X
LAMIACEAE	Stachys palustris L. ssp. pilosa (Nutt.) Epling	STPA2	Y						X
LEMNACEAE	Lemna minor L.	LEMI1	Y		X		X		X
LILIACEAE	Allium cernuum Roth	ALCE1	Y	X	X		X		
LILIACEAE	Allium georgii S. Wats.	ALGE1	Y	X					X
LILIACEAE	Allium textile A. Nels. & Macbr.	ALTE1	Y	X	X		X		X
LILIACEAE	Asparagus officinalis L.	ASOF1	N		X		X		X
LILIACEAE	Calochortus gunnisonii S. Wats.	CAGU1	Y	X	X		X		X
LILIACEAE	Leucocrinum montanum Nutt.	LEMO2	Y	X			X		X
LILIACEAE	Smilacina stellata (L.) Desf.	SMST1	Y		X		X		X
LILIACEAE	Zigadenus venenosus Wats. var. gramineus (Rydb.) Walsh ex Peck	ZIVE1	Y	X	X		X		X
LINACEAE	Linum perenne L. var. lewisii (Pursh.) Eat. & Wright	LIPE1	Y	X	X		X		X
LYTHRACEAE	Lythrum alatum Pursh.	LYAL1	Y		X		X		X
MALVACEAE	Malva neglecta Wallr.	MANE1	N	X					
MALVACEAE	Sidalcea candida Gray	SICA1	Y				X		X
MALVACEAE	Sphaeralcea coccinea (Pursh.) Rydb.	SPCO1	Y	X			X		X
NYCTAGINACEAE	Mirabilis hirsuta (Pursh.) MacM.	MIHI1	Y	X	X		X		X
NYCTAGINACEAE	Mirabilis linearis (Pursh.) Heimerl	MILI1	Y	X			X		X
NYCTAGINACEAE	Mirabilis nyctaginea (Michx.) MacM.	MINY1	Y		X		X		X
ONAGRACEAE	Calylophus serrulatus (Nutt.) Raven	CASE2	Y	X			X		
ONAGRACEAE	Epilobium ciliatum Raf. ssp. glandulosum (Lehm.) Hock & Raven	EPCI1	Y		X		X		X
ONAGRACEAE	Epilobium paniculatum Nutt.	EPPA1	Y		X		X		X
ONAGRACEAE	Gaura coccinea Pursh.	GACO1	Y	X	X		X		X
ONAGRACEAE	Gaura parviflora Dougl.	GAPA1	Y		X				X
ONAGRACEAE	Oenothera howardii (A. Nels.) W. L. Wagner	OEHO1	Y	X			X		X
ONAGRACEAE	Oenothera villosa Thunb. ssp. strigosa (Rydb.) Dietrich & Raven	OEVI1	Y	X	X		X		X
ORCHIDACEAE	Habenaria hyperborea (L.) R. Br.	HAHY1	Y						X
OROBANCHACEAE	Orobanche fasciculata Nutt.	ORFA1	Y	X			X		
OXALIDACEAE	Oxalis dillenii Jacq.	OXDI1	N	X	X		X		X

TABLE 5-2. (cont.)

Family	Scientific Name	Speccode	Native	Xeric		Tall Upland	Great Plains
				Tallgrass	Wetlands	Shrubland	Riparian
				Prairie			Woodland
PAPAVERACEAE	Argemone polyanthemus (Fedde) G. Ownbey	ARPO1	Y	X			X
PINACEAE	Pinus ponderosa Laws	PIPO1	Y	X		X	X
PINACEAE	Pseudotsuga menziesii (Mirb.) Franco	PSME1	Y	X		X	
PLANTAGINACE	Plantago lanceolata L.	PLLA1	N	X	X	X	X
PLANTAGINACE	Plantago major L.	PLMA1	N			X	X
PLANTAGINACE	Plantago patagonica Jacq.	PLPA1	Y	X			
POACEAE	Aegilops cylindrica Host	AECY1	N			X	
POACEAE	Agropyron caninum (L.) Beauv. ssp. majus (Vasey) C. L. Hitchc.	AGCA1	Y	X		X	X
POACEAE	Agropyron cristatum (L.) Gaertn.	AGCR1	N	X	X	X	X
POACEAE	Agropyron dasystachyum (Hook.) Scribn.	AGDA1	Y		X	X	X
POACEAE	Agropyron desertorum (Fisch.) Schult.	AGDE1	N	X	X	X	X
POACEAE	Agropyron griffithsii Scribn. & Smith	AGGR1	Y	X		X	
POACEAE	Agropyron intermedium (Host) Beauv.	AGIN1	N	X	X	X	X
POACEAE	Agropyron repens (L.) Beauv.	AGRE1	N		X	X	X
POACEAE	Agropyron smithii Rydb.	AGSM1	Y	X	X	X	X
POACEAE	Agrostis scabra Willd.	AGSC1	Y	X	X	X	
POACEAE	Agrostis stolonifera L.	AGST1	N		X	X	X
POACEAE	Alopecurus geniculatus L.	ALGE2	Y	X	X		
POACEAE	Andropogon gerardii Vitman	ANGE1	Y	X	X	X	X
POACEAE	Andropogon scoparius Michx.	ANSC1	Y	X	X	X	X
POACEAE	Aristida basiramea Engelm. ex Vasey var. basiramea	ARBA1	Y	X			
POACEAE	Aristida purpurea Nutt. var. longiseta (Steud.) Vasey	ARFE1	Y	X		X	
POACEAE	Aristida purpurea Nutt. var. robusta (Merrill) A. Holmgren & N. Holmgr	ARLO1	Y	X	X	X	X
POACEAE	Bouteloua curtipendula (Michx.) Torr.	BOCU1	Y	X	X	X	X
POACEAE	Bouteloua gracilis (H. B. K.) Lag ex Griffiths	BOGR1	Y	X	X	X	X
POACEAE	Bouteloua hirsuta Lag	BOHI1	Y	X	X	X	X
POACEAE	Bromus briziformis F. & M.	BRBR1	N			X	
POACEAE	Bromus inermis Leyss. ssp. inermis	BRIN1	N	X	X	X	X
POACEAE	Bromus japonicus Thunb. ex Murr.	BRJA1	N	X	X	X	X
POACEAE	Bromus tectorum L.	BRTE1	N	X	X	X	X
POACEAE	Buchloe dactyloides (Nutt.) Engelm.	BUDA1	Y	X			X
POACEAE	Ceratochloa marginata (Nees ex Stued.) Jackson	CEMA1	Y		X	X	
POACEAE	Dactylis glomerata L.	DAGL1	N	X	X	X	X
POACEAE	Danthonia spicata (L.) Beauv. ex R. & S.	DASP1	Y	X			
POACEAE	Dichanthelium oligosanthos (Schultz) Gould var. scribnerianum (Nash) G	DIOL1	Y	X		X	X
POACEAE	Echinochloa crusgallii (L.) Beauv.	ECGR1	N				X
POACEAE	Elymus canadensis L.	ELCA1	Y	X	X	X	X
POACEAE	Elymus juncea Fisch.	ELJU1	N	X			
POACEAE	Festuca octoflora Walt.	FEOC1	Y				X
POACEAE	Festuca ovina L. var. rydbergii St. Yves	FEOV1	Y	X		X	X
POACEAE	Festuca pratensis Huds.	FEPR1	Y		X		X

TABLE 5-2. (cont.)

Family	Scientific Name	Speccode	Native	Xeric Tallgrass		Tall Upland		Great Plains	
				Prairie	Wetlands	Shrubland	Woodland	Riparian	Woodland
POACEAE	<i>Glyceria grandis</i> S. Wats. ex A. Gray	GLGR1	Y		X	X			X
POACEAE	<i>Glyceria striata</i> (Lam.) Hitchc.	GLST1	Y		X	X			X
POACEAE	<i>Hordeum jubatum</i> L.	HOJU1	Y		X	X			X
POACEAE	<i>Koeleria pyramidata</i> (Lam.) Beauv.	KOPY1	Y	X	X	X			X
POACEAE	<i>Leersia oryzoides</i> (L.) Sw.	LEOR1	Y						X
POACEAE	<i>Lolium perenne</i> L.	LOPE1	N	X					
POACEAE	<i>Muhlenbergia filiformis</i> (Thurb.) Rydb.	MUFI1	Y		X				
POACEAE	<i>Muhlenbergia montana</i> (Nutt.) Hitchc.	MUMO1	Y	X		X			X
POACEAE	<i>Muhlenbergia racemosa</i> (Michx.) B. S. P.	MURA1	Y		X	X			X
POACEAE	<i>Oryzopsis hymenoides</i> (R. & S.) Ricker	ORHY1	Y	X		X			
POACEAE	<i>Panicum capillare</i> L.	PACA1	Y						X
POACEAE	<i>Panicum virgatum</i> L.	PAVI1	Y	X	X	X			X
POACEAE	<i>Phalaris arundinacea</i> L.	PHAR1	Y						X
POACEAE	<i>Phleum pratense</i> L.	PHPR1	N	X	X	X			X
POACEAE	<i>Poa canbyi</i> (Scribn.) Piper	POCA1	Y	X					
POACEAE	<i>Poa compressa</i> L.	POCO1	N	X	X	X			X
POACEAE	<i>Poa fendleriana</i> (Steud.) Vasey	POFE1	Y	X					
POACEAE	<i>Poa palustris</i> L.	POPA1	N		X	X			X
POACEAE	<i>Poa pratensis</i> L.	POPR1	N	X	X	X			X
POACEAE	<i>Polypogon monspeliensis</i> (L.) Desf.	POMO1	N						X
POACEAE	<i>Secale cereale</i> L.	SECE1	N	X		X			X
POACEAE	<i>Setaria viridis</i> (L.) Beauv.	SEVI1	N	X					
POACEAE	<i>Sitanion hystrix</i> (Nutt.) Sm. var. <i>brevifolium</i> (Sm.) Hitchc.	SIHY1	Y	X		X			X
POACEAE	<i>Sorghastrum nutans</i> (L.) Nash	SONU1	Y	X	X	X			X
POACEAE	<i>Spartina pectinata</i> Link	SPPE1	Y		X	X			X
POACEAE	<i>Sporobolus asper</i> (Michx.) Kunth	SPAS1	Y	X		X			X
POACEAE	<i>Sporobolus cryptandrus</i> (Torr.) A. Gray	SPCR1	Y	X	X	X			X
POACEAE	<i>Sporobolus heterolepis</i> (A. Gray) A. Gray	SPHE1	Y	X	X	X			X
POACEAE	<i>Stipa comata</i> Trin. & Rupr.	STCO1	Y	X	X	X			X
POACEAE	<i>Stipa spartea</i> Trinius	STSP1	Y	X		X			
POACEAE	<i>Stipa viridula</i> Trin.	STVI1	Y	X	X	X			X
POACEAE	<i>X Agrohordeum macounii</i> (Vasey) Lepage	AGMA1	N			X			X
POLEMONIACEAE	<i>Collomia linearis</i> Nutt.	COLI1	Y		X	X			
POLEMONIACEAE	<i>Ipomopsis spicata</i> (Nutt.) V. Grant ssp. <i>spicata</i>	IPSP1	Y	X		X			
POLEMONIACEAE	<i>Navarretia minima</i> Nutt.	NAMI1	N	X					
POLYGONACEAE	<i>Eriogonum alatum</i> Torr.	ERAL1	Y	X		X			X
POLYGONACEAE	<i>Eriogonum effusum</i> Nutt.	EREF1	Y	X					X
POLYGONACEAE	<i>Eriogonum jamesii</i> Benth.	ERJA1	Y			X			
POLYGONACEAE	<i>Eriogonum umbellatum</i> Torr.	ERUM1	Y	X		X			X
POLYGONACEAE	<i>Polygonum convolvulus</i> L.	POCO2	N	X	X	X			X
POLYGONACEAE	<i>Polygonum douglasii</i> Greene	PODO1	Y		X	X			X

TABLE 5-2. (cont.)

Family	Scientific Name	Speccode	Native	Xeric Tallgrass		Tall Upland	Great Plains	
				Prairie	Wetlands	Shrubland	Riparian	Woodland
POLYGONACEAE	<i>Polygonum hydropiper</i> L.	POHY1	N			X		
POLYGONACEAE	<i>Polygonum lapathifolium</i> L.	POLA1	N					X
POLYGONACEAE	<i>Polygonum pennsylvanicum</i> L.	POPE1	Y		X			
POLYGONACEAE	<i>Polygonum persicaria</i> L.	POPE2	N		X	X		
POLYGONACEAE	<i>Polygonum ramosissimum</i> Michx.	PORA1	Y	X		X		
POLYGONACEAE	<i>Polygonum sawatchense</i> Small	POSA1	Y		X	X		
POLYGONACEAE	<i>Rumex acetosella</i> L.	RUAC1	N	X		X		X
POLYGONACEAE	<i>Rumex crispus</i> L.	RUCR1	N	X	X	X		X
POLYGONACEAE	<i>Rumex obtusifolius</i> L.	RUOB1	N		X	X		X
POLYGONACEAE	<i>Rumex salicifolius</i> Weinm. ssp. <i>triangulivalvis</i> Danser	RUSA1	Y	X	X	X		X
POLYPODIACEAE	<i>Cystopteris fragilis</i> (L.) Bernh.	CYFR1	Y			X		
PORTULACACEAE	<i>Claytonia rosea</i> Rydb.	CLRO1	Y			X		
PORTULACACEAE	<i>Portulaca oleracea</i> L.	POOL1	N		X			
PORTULACACEAE	<i>Talinum parviflorum</i> Nutt.	TAPA1	Y	X				X
POTAMOGETONACEAE	<i>Potamogeton foliosus</i> Raf.	POFO1	Y		X			
POTAMOGETONACEAE	<i>Potamogeton natans</i> L.	PONA1	Y		X			
PRIMULACEAE	<i>Androsace occidentalis</i> Pursh.	ANOC1	Y	X	X			X
PRIMULACEAE	<i>Lysimachia ciliata</i> L.	LYCI1	Y		X	X		X
RANUNCULACEAE	<i>Anemone cylindrica</i> A. Gray	ANCY1	Y			X		
RANUNCULACEAE	<i>Anemone patens</i> L.	ANPA2	Y	X				
RANUNCULACEAE	<i>Clematis ligusticifolia</i> Nutt.	CLLI1	Y	X		X		X
RANUNCULACEAE	<i>Delphinium nuttalianum</i> Pritz. ex Walpers	DENU1	Y	X		X		X
RANUNCULACEAE	<i>Delphinium virescens</i> Nutt. ssp. <i>penardii</i> (Huth) Ewan	DEVI1	Y	X		X		X
RANUNCULACEAE	<i>Myosurus minimus</i> L.	MYMI1	Y	X				
RANUNCULACEAE	<i>Ranunculus macounii</i> Britt.	RAMA1	Y		X	X		X
RANUNCULACEAE	<i>Ranunculus trichophyllus</i> Chaix	RATR1	Y		X			X
RANUNCULACEAE	<i>Thalictrum dasycarpum</i> Fisch. & Ave-Lail	THDA1	Y		X	X		X
RHAMNACEAE	<i>Ceanothus herbaceus</i> Raf. var. <i>pubescens</i> (T. & G.)	CEHE1	Y			X		
ROSACEAE	<i>Agrimonia striata</i> Michx.	AGST2	Y		X	X		X
ROSACEAE	<i>Amelanchier alnifolia</i> Nutt.	AMAL1	Y	X		X		
ROSACEAE	<i>Crataegus erythropoda</i> Ashe	CRER1	Y	X	X	X		X
ROSACEAE	<i>Crataegus succulenta</i> Link var. <i>occidentalis</i> (Britton) E. J. Palm.	CRSU1	Y			X		
ROSACEAE	<i>Geum aleppicum</i> Jacq.	GEAL1	Y		X	X		X
ROSACEAE	<i>Geum macrophyllum</i> Willd.	GEMA1	Y	X	X	X		X
ROSACEAE	<i>Physocarpus monogynus</i> (Torr.) Coult.	PHMO1	Y			X		
ROSACEAE	<i>Physocarpus opulifolius</i> (L.) Raf.	PHOP1	Y			X		
ROSACEAE	<i>Potentilla arguta</i> Pursh	POAR2	Y		X			X
ROSACEAE	<i>Potentilla fissa</i> Nutt.	POFI1	Y	X		X		X
ROSACEAE	<i>Potentilla gracilis</i> Dougl. ex Hook. var. <i>glabrata</i> (Lehm.) C. L. Hitchc.	POGR1	Y	X	X	X		X
ROSACEAE	<i>Potentilla hippiana</i> Lehm.	POHI1	Y	X		X		X
ROSACEAE	<i>Potentilla norvegica</i> L.	PONO1	Y		X	X		X

TABLE 5-2. (cont.)

Family	Scientific Name	Speccode	Native	Xeric		Tall Upland	Great Plains
				Tallgrass	Wetlands	Shrubland	Riparian
ROSACEAE	Potentilla paradoxa Nutt.	POPA2	Y			X	
ROSACEAE	Potentilla pensylvanica L.	POPE4	Y	X			
ROSACEAE	Potentilla pulcherrima x hippiana	POPU1	Y				X
ROSACEAE	Prunus americana Marsh.	PRAM1	Y		X	X	X
ROSACEAE	Prunus pumila L. var. besseyi (Bailey) Gl.	PRPU1	Y	X	X	X	
ROSACEAE	Prunus virginiana L. var. melanocarpa (A. Nels.) Sarg.	PRVI1	Y	X	X	X	X
ROSACEAE	Pyrus malus L.	PYMA1	N			X	X
ROSACEAE	Rosa acicularis Lindl.	ROAC1	Y		X	X	X
ROSACEAE	Rosa arkansana Porter	ROAR1	Y	X	X	X	X
ROSACEAE	Rosa woodsii Lindl.	ROWO1	Y		X	X	X
ROSACEAE	Rubus idaeus L. ssp. sachalinensis (Levl.) Focke var. sachalinensis	RUID1	Y			X	X
RUBIACEAE	Galium aparine L.	GAAP1	Y	X	X	X	X
RUBIACEAE	Galium septentrionale Roemer & Schultes	GASE1	Y		X	X	X
SALICACEAE	Populus alba L.	POAL1	Y				X
SALICACEAE	Populus angustifolia James	POAN3	Y			X	X
SALICACEAE	Populus deltoides Marsh. ssp. monilifera (Ait.) Eckenw.	PODE1	Y	X	X	X	X
SALICACEAE	Populus x acuminata Rydb.	POAC1	Y			X	X
SALICACEAE	Salix amygdaloides Anderss.	SAAM1	Y		X	X	X
SALICACEAE	Salix exigua Nutt. ssp. interior (Rowlee) Cronq.	SAEX1	Y		X	X	X
SALICACEAE	Salix fragilis L.	SAFR1	N				X
SALICACEAE	Salix irrorata Andersson	SAIR1	Y			X	X
SALICACEAE	Salix lutea Nutt.	SALU1	Y				X
SANTALACEAE	Comandra umbellata (L.) Nutt.	COUM1	Y	X	X	X	X
SAXIFRAGACEAE	Heuchera parvifolia Nutt. ex T. & G.	HEPA1	Y	X		X	
SAXIFRAGACEAE	Saxifraga rhomoidea Greene	SARH1	Y	X			
SCROPHULARIACEAE	Castilleja integra A. Gray	CAIN2	Y	X			
SCROPHULARIACEAE	Castilleja sessiliflora Pursh.	CASE3	Y	X		X	
SCROPHULARIACEAE	Collinsia parviflora Doug. ex Lindl.	COPA1	Y	X		X	
SCROPHULARIACEAE	Linaria dalmatica (L.) Mill.	LIDA1	N	X	X	X	X
SCROPHULARIACEAE	Linaria vulgaris Hill	LIVU1	N	X	X		
SCROPHULARIACEAE	Mimulus glabratus H. B. K. var. fremontii (Benth.) A. L. Grant	MIGL1	Y		X		
SCROPHULARIACEAE	Penstemon secundiflorus Benth.	PESE1	Y	X	X	X	X
SCROPHULARIACEAE	Penstemon strictus Benth. in De Candolle	PEST1	Y	X			
SCROPHULARIACEAE	Penstemon virens Penn.	PEVI1	Y	X	X	X	X
SCROPHULARIACEAE	Penstemon virgatus Gray ssp. asa-grayi Crosswhite	PEVI2	Y	X	X	X	X
SCROPHULARIACEAE	Scrophularia lanceolata Pursh.	SCLA2	Y		X	X	X
SCROPHULARIACEAE	Verbascum blattaria L.	VEBL1	N	X	X	X	X
SCROPHULARIACEAE	Verbascum thapsus L.	VETH1	N	X	X	X	X
SCROPHULARIACEAE	Veronica americana (Raf.) Schwein. ex Benth.	VEAM1	Y		X	X	X
SCROPHULARIACEAE	Veronica anagallis-aquatica L.	VEAN1	N		X	X	X
SCROPHULARIACEAE	Veronica peregrina L. var. xalapensis (H. B. K.) St. John & Warren	VEPE1	Y	X			X

TABLE 5-2. (cont.)

Family	Scientific Name	Speccode	Native	Xeric		Wetlands	Great Plains	
				Tallgrass	Prairie		Tall Upland	Riparian
							Shrubland	Woodland
SELAGINELLACEAE	Selaginella densa Rydb.	SEDE1	Y		X			
SMILACACEAE	Smilax herbacea L. var. lasioneura (Small) Rydb..	SMHE1	Y				X	
SOLANACEAE	Physalis heterophylla Nees	PHHE2	Y	X		X	X	X
SOLANACEAE	Physalis virginiana P. Mill.	PHV12	Y	X		X	X	X
SOLANACEAE	Solanum triflorum Nutt.	SOTR1	Y	X				
TYPHACEAE	Typha angustifolia L.	TYAN1	Y					X
TYPHACEAE	Typha latifolia L.	TYLA1	Y			X	X	X
ULMACEAE	Ulmus pumila L.	ULPU1	N	X		X		X
URTICACEAE	Parietaria pensylvanica Muhl. ex Willd.	PAPÉ1	Y				X	
URTICACEAE	Urtica dioica L. ssp. gracilis (Ait.) Seland.	URDI1	Y			X	X	X
VERBENACEAE	Lippia cuneifolia (Torr.) Steud.	LICU1	Y	X				X
VERBENACEAE	Verbena bracteata Lag. & Rodr.	VEBR1	Y	X		X	X	X
VERBENACEAE	Verbena hastata L.	VEHA1	Y			X	X	X
VIOLACEAE	Viola nuttallii Pursh.	VINU1	Y	X			X	
VIOLACEAE	Viola rydbergii Greene	VIRY1	Y				X	
VIOLACEAE	Viola scopulorum (Gray) Greene	VISC1	Y				X	
VIOLACEAE	Viola sororia Willd.	VISO1	Y			X	X	X
VITACEAE	Vitis riparia Michx.	VIRI1	Y				X	X

**TABLE 5-3. 1997 SPECIES RICHNESS SORENSON COEFFICIENT OF  
SIMILARITY INDICES BETWEEN HIGH-VALUE VEGETATION COMMUNITIES**

	Xeric Tallgrass Prairie	Wetlands	Tall Upland Shrubland	Great Plains Riparian Woodland
Xeric Tallgrass Prairie	--			
Wetlands	0.56	--		
Tall Upland Shrubland	0.69	0.74	--	
Great Plains Riparian Woodland	0.62	0.77	0.78	--

**TABLE 5-4. 1997 ESTIMATED ACREAGES FOR DIFFERENT WEED SPECIES  
AT ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE**

Density	Weed Map (Estimated Total Acreage)			
	Musk Thistle	Diffuse Knapweed	Dalmation Toadflax	Mullein
High	2	696	135	117
Medium	270	893	205	238
Low	202	658	82	203
Scattered	-	431	-	17
<b>Total Acreage</b>	<b>474</b>	<b>2678</b>	<b>422</b>	<b>575</b>

Note: These acreages are approximate and should not be interpreted as exact amounts because of the scale and precision of the mapping effort. These values may not represent all populations for these species on Site.

**TABLE 5-5. WEED CONTROL ACREAGES TREATED FROM FY1997-FY1998  
AT ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE  
(see accompanying map)**

Fiscal Year	Chemical	Total Acres Treated
1997	Tordon	275
1997	Transline	16
1998	Tordon	245
<b>Total Acreage</b>		<b>536</b>

Note: These acreages are approximate and should not be interpreted as exact amounts because of the scale and precision of the mapping effort.

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